QMA401
Trace Moisture Analyzer
User's Manual

97450 Issue 1
July 2015

Please fill out the form(s) below for each instrument that has been purchased.

Use this information when contacting Michell Instruments for service purposes.

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

QMA401

For Michell Instruments' contact information please go to
www.michell.com

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Safety

The instrument is designed to be completely safe when installed and operated correctly in accordance with the information provided in this manual.

This manual contains all the required information to install, operate and maintain this product. Prior to installation and use of this product, this entire manual should be read and understood. Installation and operation of this product should be carried out by suitably competent personnel only. The installation and operation of this product must be in accordance with the instructions provided and according to the terms of any associated safety certificates. Incorrect installation and use of this product other than those described in this manual and other than its intended purpose will render all warranties void.

This product meets the essential protection requirements of the relevant EU directives. Further details of applied directives may be found in the product specification.

Electricity and pressurized gas can be dangerous. This product must be installed and operated only by suitable trained personnel.

Warnings

Where this hazard warning symbol appears in the following sections, it is used to indicate areas where potentially hazardous operations need to be carried out and where particular attention to personal and personnel safety must be observed.

Where this symbol appears in the following sections it is used to indicate areas of potential risk of electric shock.

Electrical Safety

Ensure electrical safety is complied with by following the directions provided here and observing all local operation & installation requirements at the intended location of use.

This product is completely safe when using any options and accessories supplied by the manufacturer of this product for use with it. Refer to Section 2 (Installation) of this manual for further details.

Pressure Safety

For this product to operate satisfactorily, pressurized gas must be connected to it. Observe all the information contained within this manual and all local operation & installation requirements at the intended location of use. Refer to Section 2 (Installation) of this manual for further details.

Hazardous Materials (WEEE, RoHS2 & REACH)

This product does not contain or release any prohibited chemicals listed on the SVHC (Substances of Very High Concern) Candidate List. During the intended normal operation of this product it is not possible for the user to come into contact with any hazardous materials. This product is designed to be recyclable except where indicated, see relevant sections in this manual for further details.

Calibration (Factory Validation)

Prior to shipment, the instrument undergoes stringent factory calibration to traceable standards. Due to the inherent stability of the instrument, regular factory calibration is not required under normal operating conditions. The instrument should perform reliably for many years with just basic maintenance, housekeeping and regular field calibrations from the internal reference (moisture generator) or a known external reference.

There are, however some consumables that will require periodic replacement.

- Moisture generator - typical lifetime of around 3 years.
- Desiccant column - typical lifetime of around 2 years, but this strongly depends on the moisture content of the sample gas. The drier the sample gas, the longer lifetime of the desiccant.

Michell Instruments can provide a fully traceable factory calibration service for the instrument and it is recommended that this is considered at intervals of every year of the analyzer's life. Please contact your local Michell Instruments' office or representative for further details (www.michell.com).

Repair and Maintenance

Apart from user-replaceable components required for routine operational maintenance described above, the analyzer must only be maintained either by the manufacturer or an accredited service agent. Refer to www.michell.com for details of Michell Instruments' worldwide offices contact information.

Abbreviations

The following abbreviations are used in this manual:

A	ampere
AC	alternating current
atm	pressure unit (atmosphere)
bara	pressure unit (=100 kP or 0.987 atm) (absolute)
barg	pressure unit (=100 kP or 0.987 atm) gauge
°C	degrees Celsius
°F	degrees Fahrenheit
EU	European Union
hr	hour
Hz	Hertz
IEC	International Electrotechnical Commission
IP	Internet protocol
ml/min	milliliters per minute
mg/m^3	milligrams per cubic meter
lbs/MMscf	pounds per million standard cubic feet
mA	milliampere
mg/Nm^3	milligrams per normal cubic meter
ml/min	milliliters per minute
mins	minutes
mmHg	millimeter of mercury
Pa	pascal
ppm_V	parts per million (by volume)
ppm_W	parts per million (by weight)
psia	pound(s) per square inch (absolute)
psig	pound(s) per square inch (gauge)
RH	relative humidity
RS485/232	standards defining the electrical characteristics of drivers & receivers
RTC	real time clock
RTU	Remote Terminal Unit
SD	storage device card
UART	universal asynchronous receiver/transmitter
USB	Universal Serial Bus
V	Volts
"	Inch
Δ	delta
%	percentage
Ω	ohms

1 INTRODUCTION

1.1 General

The QMA401 Moisture Analyzer is designed to provide reliable, fast and accurate measurement of trace moisture content in a wide variety of applications where keeping moisture levels as low as possible is of critical importance.

The high-contrast LCD touchscreen display presents all measured data to the user in a clear and understandable format. The main display incorporates a real-time trend graph and alarm indicators based on the NAMUR 102 standard. A powerful and intuitive HMI makes control, logging and configuration of analyzer parameters straightforward.

The instrument provides two user-configurable analog outputs, and ModBus RTU communications, allowing it to interface with a SCADA DCS system, or by a computer using the dedicated application software. A pair of adjustable isolated alarm contacts allow the QMA401 to be used for direct process control.

The QMA401 offers:

- ModBus RTU
- Datalogging to SD Card
- 2 user-configurable analog outputs
- Status and Process Alarms

Minimal & Straightforward Maintenance

Sophisticated instruments are often complicated and require experience and special care in use, increasing cost of ownership. The QMA401 differs through its very uncomplicated approach to field service; the desiccant column is easy to replace via the dryer service panel on the rear of the instrument. The moisture generator has an average life span of 3 years before maintenance is required.

Automated Calibration for Continued Reliability

The QMA401 incorporates an integrated automatic calibration system for complete user confidence. Periodic calibration checks of sensor performance can be initiated on demand, or automatically (at user defined intervals and time of day), providing a verification against the calibrated moisture generator or an external reference. The moisture generator at the core of this system is supplied with a calibration traceable to NPL and NIST.

During an internal calibration cycle, the Data Hold function will prevent any interruption of dependant processes by holding the analog outputs at the same level for the duration of the calibration.

Integrated Sample Handling Components

The QMA401 features an optional bypass arrangement to increase transport speed of the sample.

A pressure regulator can also be specified to increase the range of acceptable input pressure, and to protect the instrument against pressure shocks.

1.2 Theory of Operation

The Quartz Crystal Microbalance (QCM) technology for moisture measurement is based on monitoring the frequency of a hygroscopic-coated quartz crystal with specific sensitivity to water vapor.

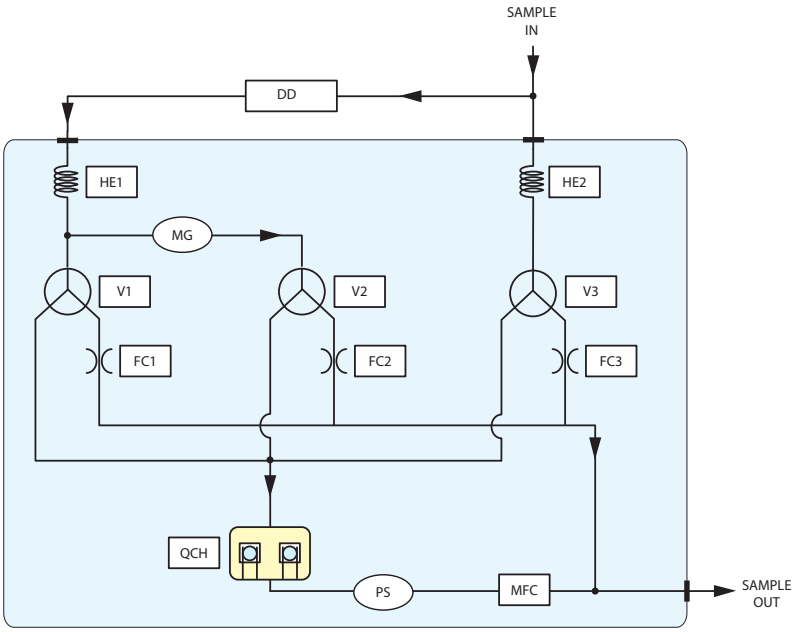
Bulk adsorption of water vapor onto the coated crystal causes an increase in the crystals effective mass, modifying its oscillation frequency in a very precise and repeatable manner. The frequency change is in proportion to the water vapor pressure in the sample gas, providing a direct measurement of moisture content.

The sorption process is fully reversible with no long-term drift effect, giving a highly reliable and repeatable measurement.

1.3 Sample Gas Path

The QMA401 measurement system must be supplied with gas at the required pressure (to match that of its calibration) via the VCR connection on the rear of the instrument. The flow is controlled automatically.

The sensor cell is located at the end of the sensor block and contains the sensor and reference oscillators. *Figure 1* shows a schematic diagram of this sampling system:

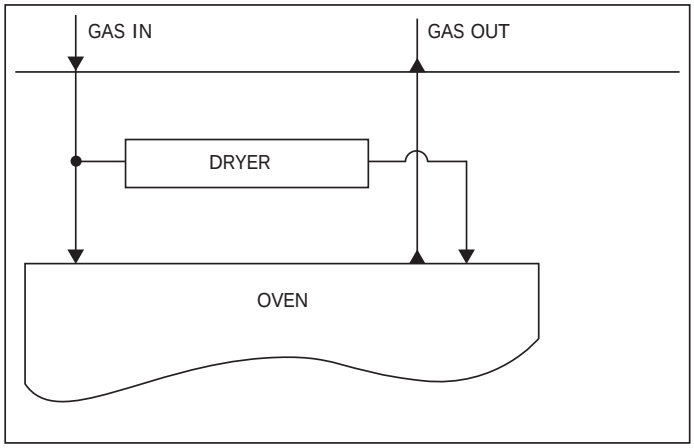


Key			
DD	Desiccant column	**MG**	Moisture generator
MFC	Mass flow controller	**V1, V2, V3**	Solenoid Valves
QCH	Sensor cell	**HE1/HE2**	Heat exchanger
PS	Pressure sensor	**FC1**	Flow control

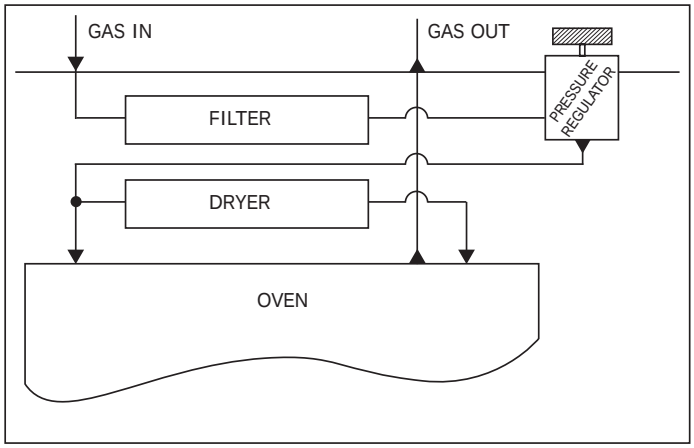
Figure 1 *Measurement System*

1.4 Internal Sampling Options

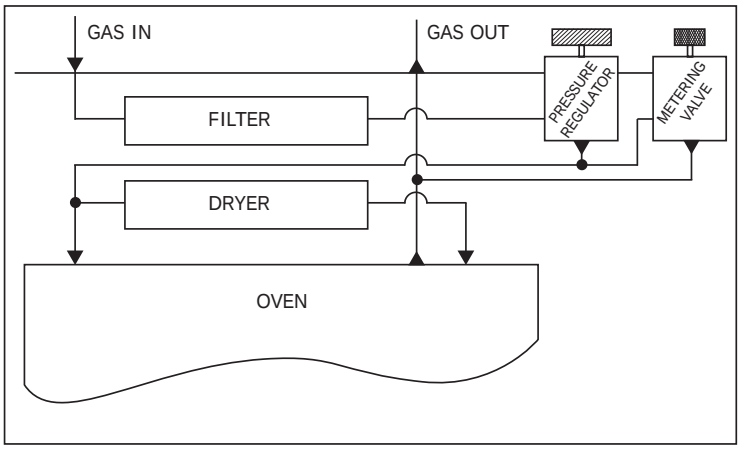
The QMA401 is available with 3 internal sampling configurations.



S1 - Default option



S2 - Includes 2µm filter and pressure regulator, allowing the QMA401 to accept greater sample pressures.



S3 - Includes 2µm filter, pressure regulator and bypass metering valve, for fast sample transport to the instrument.

Figure 2 *Internal Sampling Options*

2 INSTALLATION

2.1 Analyzer Storage Instructions

In order for this product to be functional upon installation it should be stored in accordance with the guidelines below:

- The product must be housed in a sheltered area, out of direct sunlight and rain.
- The product should be stored to minimize the possibility of sitting in ground water.
- The temperature within the storage environment should be maintained between -20 to +60°C (-4 to +140°F).
- The humidity within the storage environment must be non-condensing.
- The storage environment must not expose the analyzer to any corrosive elements.
- The product may stay assembled with its sample conditioning system (if supplied).
- All electrical and process connections should remain disconnected and capped.
- All protective coatings should remain in place until installation.
- For prolonged periods of storage, the lid of the packaging crate should be removed to allow air to circulate.
- Any documentation supplied with the product should be removed from the packaging crate and stored elsewhere to protect its integrity.

For the period from installation of the product to commissioning start-up, the following precautions should be followed:

- The product and associated sampling system (if supplied) must remain isolated from the process gas, and the enclosure should remain closed to ensure ingress protection is maintained.
- If supplied, the sampling system enclosure heating/thermostat circuit should be operated if the climatic temperature might fall below +5°C (+41°F).
- At time of start-up the procedures contained in the user manuals for both analyzer and sampling system must be followed.

If the product was previously in service/operation then the following precautions should be followed before storage:

- Upon isolation from the gas sample the entire system should be purged with a dry nitrogen gas before powering down of the analyzer.
- All connections and ports (gas and electrical) to the analyzer or sample system (if provided) should be capped.
- If the product is not removed from its location, the electrical grounding of the analyzer should remain in place.

2.2 Unpacking the Instrument

Open the crate and carefully unpack the instrument.

NOTE: Retain the packaging in case the instrument is returned for factory calibration or service.

The accessories box should contain the following items:

- Traceable calibration certificate
- SD memory storage card
- USB communications cable
- IEC power cable
- Application software CD
- Users manual

If there are any shortages please notify the supplier immediately.

2.3 Electrical Requirements

The QMA401 requires the following electrical supply:

- 85 to 264 V AC 47/63Hz, 250 VA max
- Alarm outputs comprise four sets of changeover relay contacts, one set for INTERNAL FAULTS, and three sets for PROCESS alarms. All contacts are rated at 24 V, 1A. **NOTE: THIS RATING MUST NOT BE EXCEEDED**

Fuse

This product is provided with an internally mounted fuse. A replacement fuse can be obtained by contacting Michell Instruments' technical support. Fuse rating = 5 x 20mm 3 A anti-surge to IEC 60127-2.

Power Connection

The product is provided with an IEC C13 socket on the rear panel for mains power input.

This equipment must be supplied with a voltage between the range of 85 to 264 V AC 47/63Hz, maximum required power is 140 W.

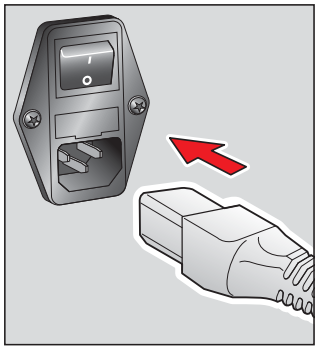
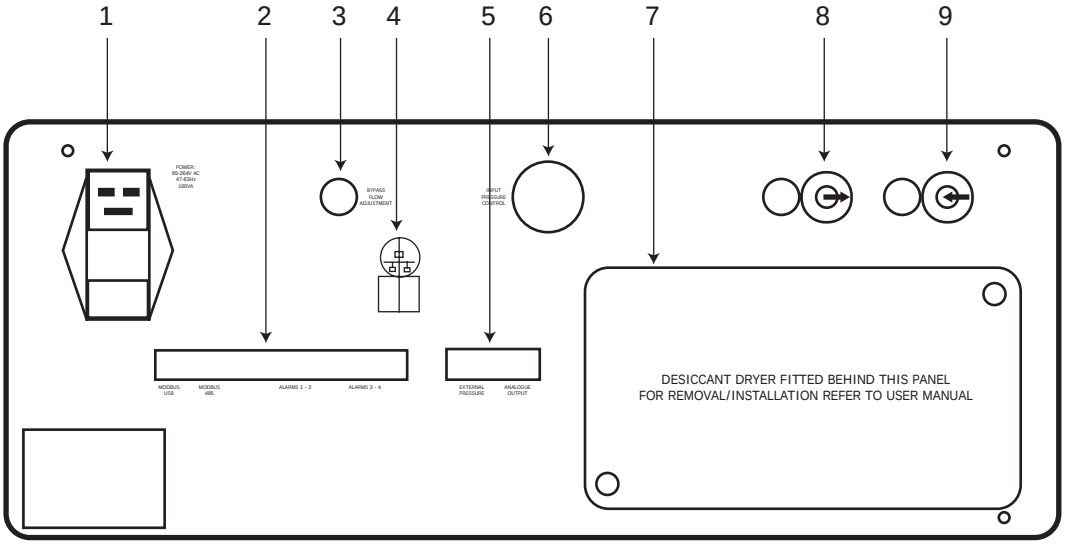


Figure 3 *Power Connection*

2.4 Rear Panel Connections



1	Power Connection	IEC Power Socket, On/Off Switch & Fuse	
2	Electrical Connections #1	USB	
		RS485 (Modbus)	A
			B
			G
		Alarms 1 & 2	NC1
			NO1
			COM1
			NC2
			NO2
			COM2
		Alarms 3 & 4	NC3
			NO3
			COM3
			NC4
			NO4
			COM4
3	Bypass Flow Adjustment		
4	Input Pressure Control		
5	Ethernet		
6	Electrical Connections #2	External Pressure	+24V
			Signal
		Analog Output	OP1+
			OP1-
			OP2+
			OP2-
7	Desiccant Column Access Panel		
8	Gas Outlet		
9	Gas Inlet		

Figure 4 *Rear Panel Connections*

2.5 Pressure Safety

WARNING:

This product is used in conjunction with pressurized gases. Observe pressurized gas handling precautions.

WARNING:

Pressurized gas is dangerous and should only handled by suitably trained personnel.

DO NOT permit pressures greater than the specified safe working pressure to be applied directly to the instrument.

For the calibration to remain valid the QMA401 must be operated at the pressures specified on the calibration certificate (typically a sample pressure of 1 barg (14.5 psig), with the outlet at atmospheric pressure). When using the pressure control option, the cell pressure should never exceed the maximum stipulated operating pressure of 1 barg (14.5 psig).

2.6 Connection of Gas Supplies

Sample gas connections are made via the gas inlet and outlet 1/4" VCR ports located on the rear panel of the instrument as shown in *Figure 5*. All connections should be made with high quality stainless steel tubing.

NOTE: No external gas couplings are supplied with the analyzer but can be ordered as an accessory by contacting Michell Instruments - see www.michell.com for contact details.

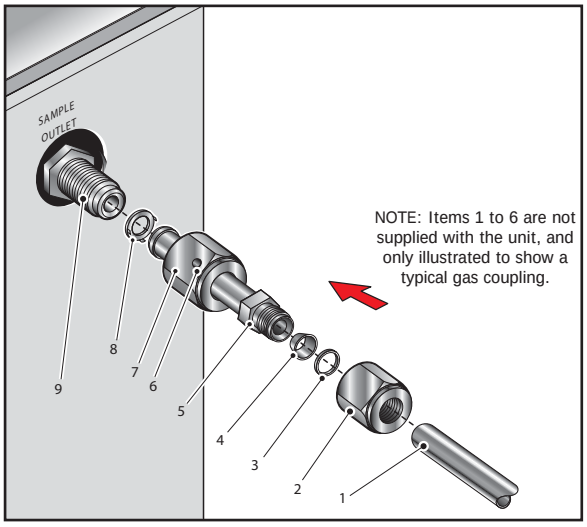


Figure 5 *Typical Gas Connections*

Making a connection to the 1/4" VCR fitting:

1. Clip the gasket and its retaining ring (8) over the end of the VCR adaptor (5).
2. Locate the end of the VCR adaptor (5), fitted with the gasket (8) over the VCR port (9) and screw the locking nut (7) finger tight to fix the adaptor to the port.
3. Tighten the locking nut (7) one eighth of a turn.

Connection to a VCR to 1/4" Swagelok tube adaptor:
(available as an accessory)

1. Cut ¼" stainless steel tubing (1) to the correct length and, if necessary, bend to shape to suit the location of the instrument. **NOTE: To facilitate ease of connection to the adaptor (5), at least 75mm (3 in) of the tubing coming out of the adaptor must be straight.**
2. Clean off any burrs or metal shavings adhering to the tubing.
3. Pass the tubing (1) through the locking nut (2), and the back ferrule (3).
4. Place the front ferrule (4) over the stainless steel tubing (1), bevelled end towards the adaptor (5).
5. Insert the stainless steel tubing (1) as far as it will go into the adaptor (5) and tighten up the locking nut (2) finger tight.
6. Hold the adaptor (5) flats with a spanner and tighten up the locking nut (2). This action compresses the front ferrule (4) and back ferrule (3) onto the tubing to form a gas tight seal. **Caution: Do not overtighten as this could cause the ferrules to crack and destroy the integrity of the seal**.

The couplings can be checked for leaks by pressurizing the system (by connecting the sample line to the process) and introducing a proprietary leak test solution into each of the test ports (6) located on the locking nut (7). If a stream of bubbles is produced then the gasket seal is leaking. If no bubbles are produced, the seal is gas tight.

If a leak is detected, tighten up the locking nut (7) a little more until the leak stops. If the leak cannot be stopped by tightening the coupling, unscrew the locking nut (7), and remove the coupling from the instrument.

Examine the ends of the coupling to check that the surfaces are not damaged and then fit a new gasket (8), re-connect and re-test.

3 OPERATION

This section describes both the general operation of the analyzer and the method of setting-up and changing the default parameters if this should become necessary.

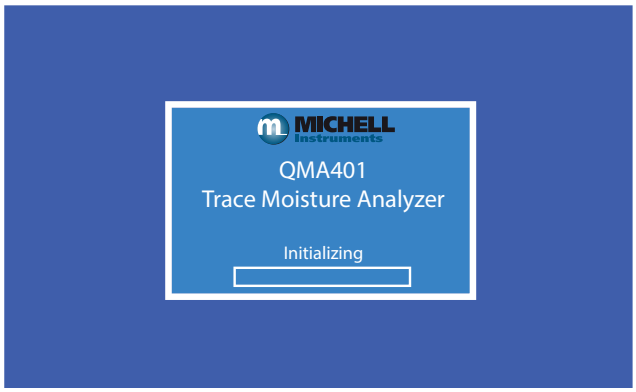
Prior to operation, the instrument must have been connected to the correct electrical power supply and the relevant analog and alarm outputs connected to external systems as required and as described in Section 2. The instrument must also have been installed as detailed in Section 2 and connected to a sample gas supply that is representative of the monitored process.

3.1 General Operational Information

Operation of the QMA401 Trace Moisture Analyzer is completely automated and once set-up requires little or no operator intervention.

3.2 First Time Operation

When the instrument is switched on an Initializing overlay will be shown while the menu system loads.



After initialization is complete, the following display will appear.

The heating period lasts about an hour, allowing time for the internal sampling system to purged with the sample gas.

3.2.1 Analyzer Set-Up

During the period when the oven is heating to set point all functions, except for HMI adjustments, are disabled until the oven has reached its operating temperature. Access the Settings menu to adjust the following parameters before operating the analyzer for the first time:

- Temperature and pressure units
- Carrier gas and pressure input
- Alarm configuration
- Analog output configuration
- Field calibration parameters
- Real time clock

Upon completion of oven heating the Main Screen will appear showing the default parameters and units (example shown below).

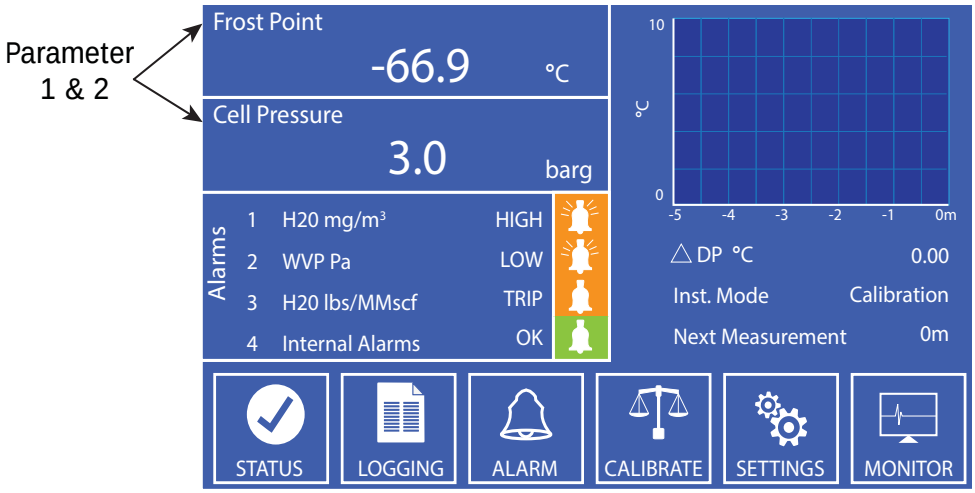


Figure 6 *Typical Display*

Using the inlet pressure regulator adjust the sample pressure until the reading on the internal sensor pressure readout matches the value on the calibration certificate. The pressure at the outlet should be atmospheric unless otherwise stated on the calibration certificate.

3.3 Menu Structure

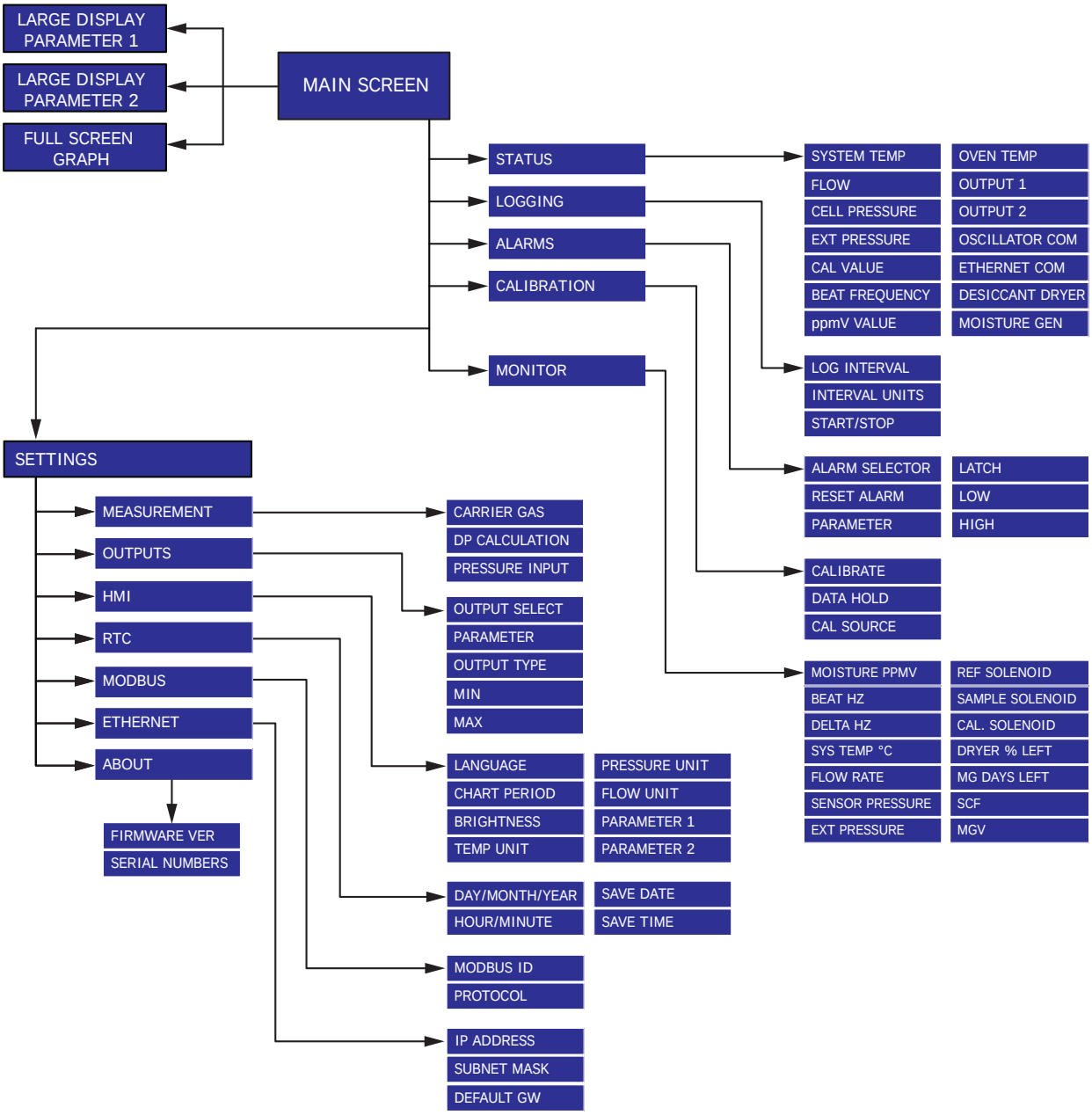


Figure 7 *Menu Structure*

3.4 Description of Measured Parameters

Moisture content ppm_V	Parts per million of H_2O by volume
Moisture content ppm_W	Parts per million of H_2O by weight
Moisture content mg/m^3	Milligrams H_2O per cubic meter gas
Water Vapor Pressure Pa	Water vapor pressure in pascals
lbs/MMscf	Pounds H_2O per million standard cubic feet
Frost Point	Frost point temperature of either ideal or natural gas depending on options set on measurement screen
Oven Temperature	Temperature of the internal oven
Flow	Gas flow rate
Cell Pressure	Pressure measured by the internal pressure transducer
Ext. Pressure	Pressure measured by an external pressure transducer (if fitted)

3.5 Main Screen

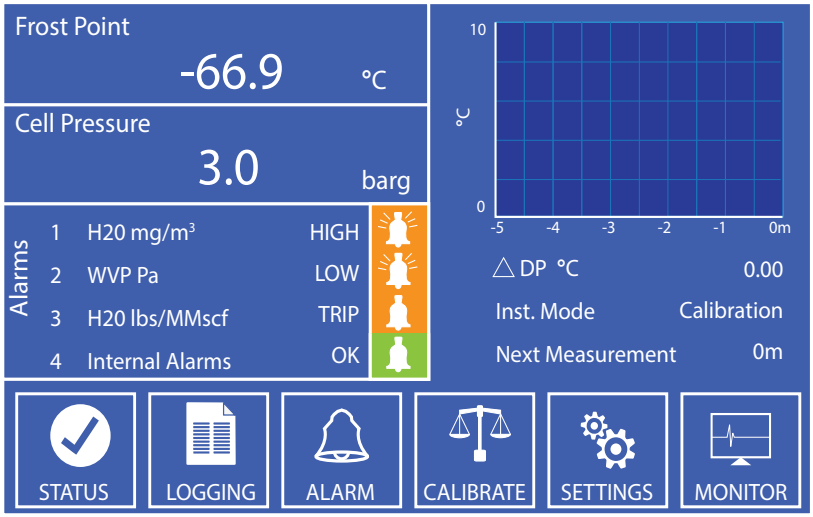


Figure 8 *Main Screen*

Parameter	Description
Parameter 1 & 2	Live reading of the selected display parameters.
Graph	Live graph reading of parameter 1.
Alarm 1, 2 & 3	The current state of the alarms. **Possible alarm states:** **Low** – Alarm type is set to Low, and has been triggered because the selected parameter is below the threshold value. **OK** – Alarm has not been triggered. **High** – Alarm type is set to High, and has been triggered because the selected parameter is above the threshold value.
Internal Alarm	Displays the state of the internal alarms. **Possible alarm states:** **No Warning / Warning! See Status**
Instrument Mode	Displays the current instrument mode. **Possible instrument modes:** **Measure** – The QMA401 is performing a measurement cycle **Cal Internal** – The QMA401 is performing a self-calibration using the internal reference **Cal External** – The QMA401 is performing a self-calibration using an external reference **Heating** – The oven is still heating to the set-point temperature
Oven Temperature/Next Mode	Displays the countdown to the next mode. If the QMA401 is in warm up mode this parameter is replaced with a live oven temperature reading.
Graph Delta	Above shown as ΔDP°C – Displays the difference between the minimum and maximum graph measurements.

Table 1 Main Screen Parameters

3.5.1 Large Display Mode

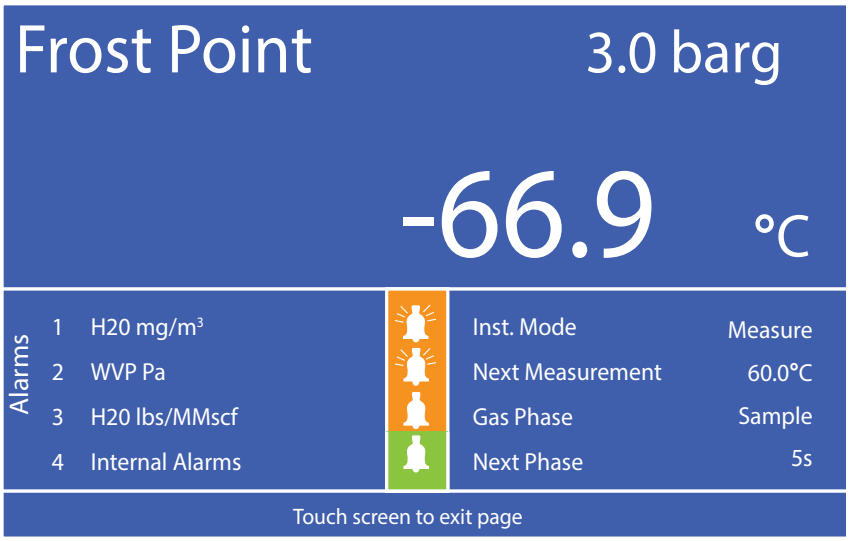


Figure 9 *Large Display Mode*

- To access large display mode, press and hold on the measurement parameter to be enlarged.
- To return to the Main Screen, touch anywhere on the screen.

3.5.2 Full Screen Graph

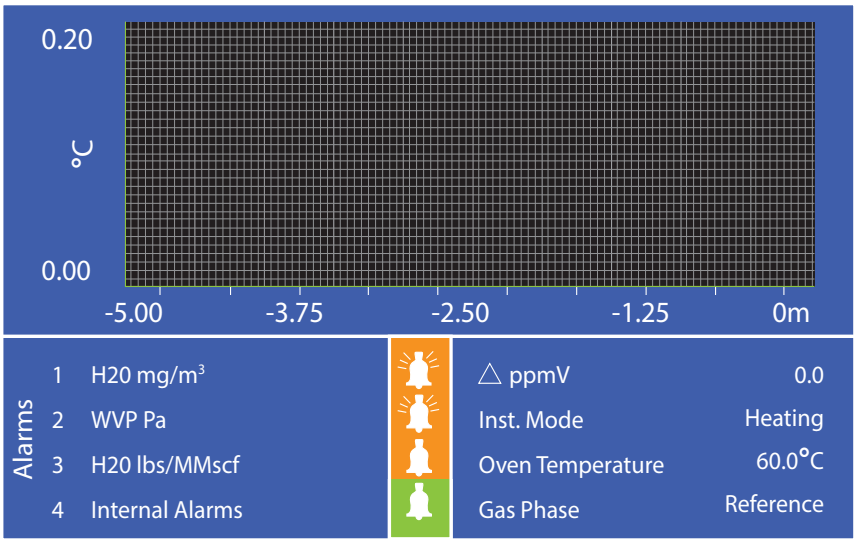


Figure 10 *Full Screen Graph*

Displays a full screen graph of Parameter 1.

- To access the full screen graph, press the graph area of the Main Screen.
- To return to the Main Screen, touch anywhere on the screen.

3.6 Main Screen Sub Menus

The following sub menus can be accessed from the Main Screen:

- Status
- Logging
- Alarms
- Calibrate
- Monitor

3.6.1 Status Screen

The buttons on this screen are used to toggle the internal alarms on/off. When an individual alarm is disabled it will not trigger the internal alarm.

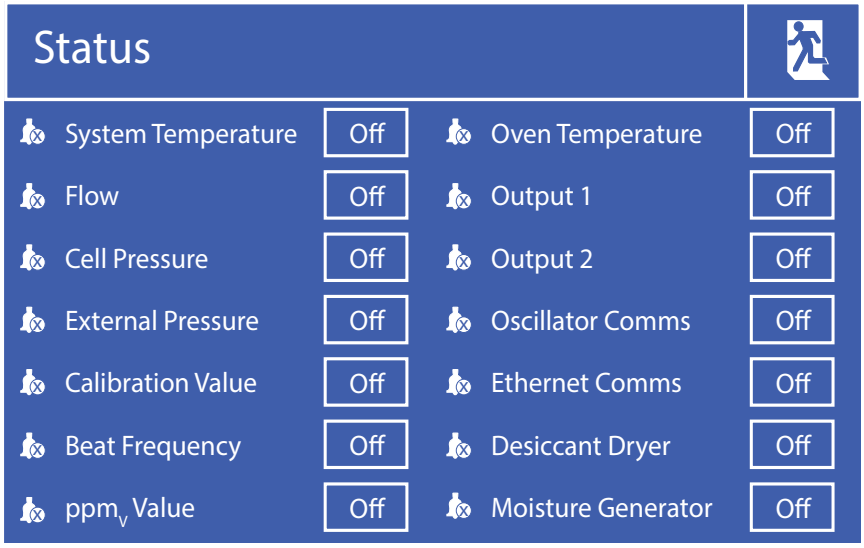


Figure 11 *Status Screen*

Displays the state of the internal alarm associated with each of the parameters above, indicated by the following icons:

Value	Description
Off	 Alarm disabled
On	 Alarm enabled. No fault
ON	 Alarm enabled. Fault condition

3.6.2 Logging Screen

Controls logging to the SD card.

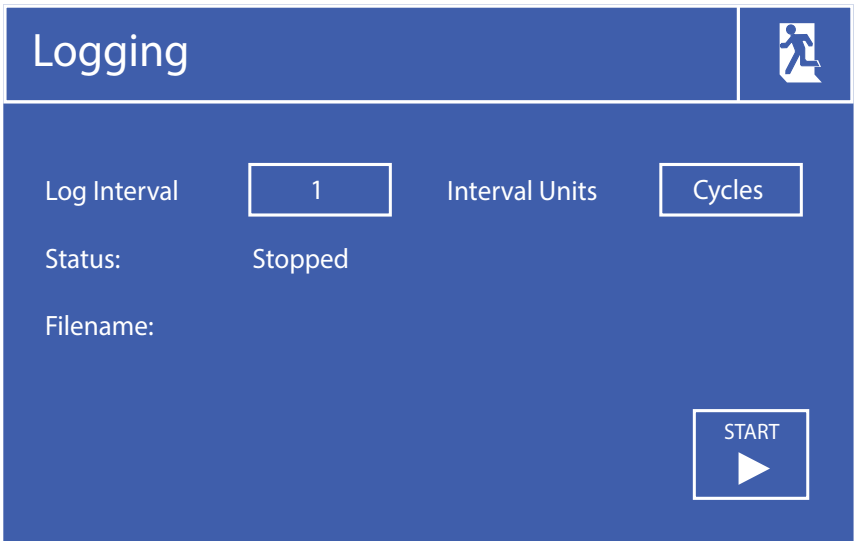
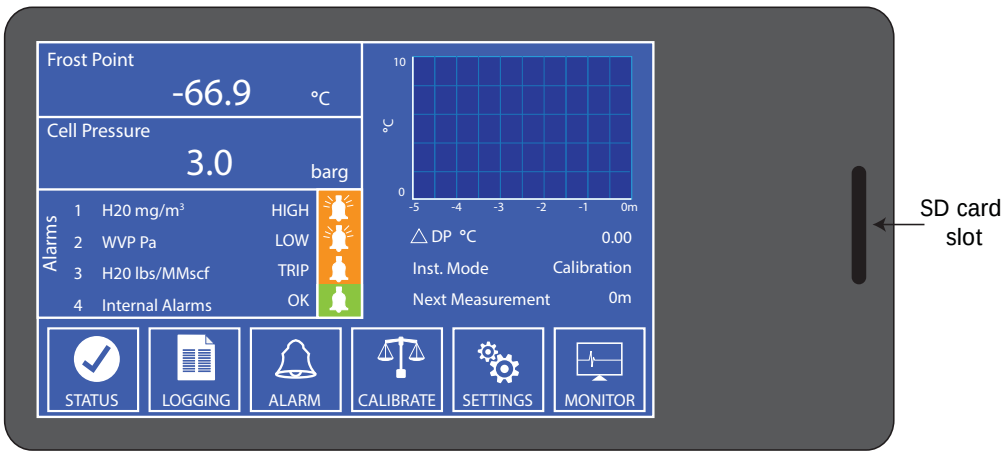


Figure 12 *Logging Screen*

Parameter	Description
Log Interval	Frequency of recording data to the log file
Interval Units	**Available Options:** Cycles, Seconds
Status	Displays status information related to logging, e.g. SD card full
Filename	Automatically generated filename based on current time and date

The SD card should be formatted as FAT32.



3.6.3 Alarm Screen

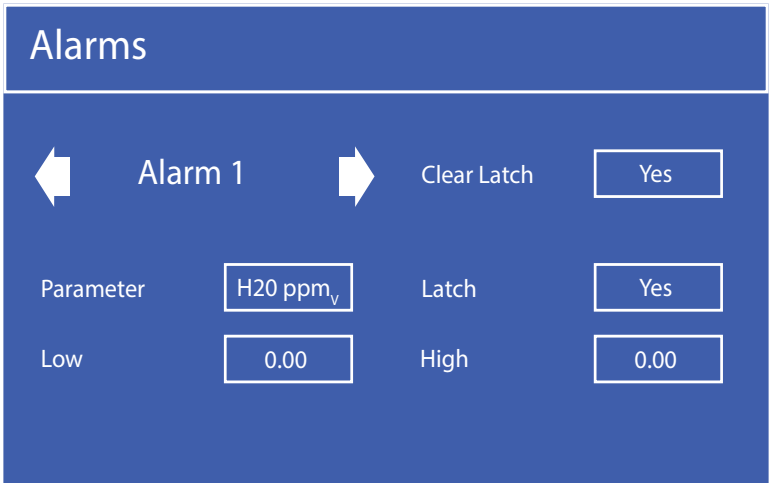


Figure 13 *Alarm Screen*

Parameter	Description
Alarm Selector	The left and right arrow keys are used to toggle through the different alarms available. **Available Options:** Alarm 1, Alarm 2, Alarm 3
Parameter	Selects the parameter for the corresponding alarm. **Available Options:** Moisture Content ppmV Moisture Content ppmW Moisture Content mg/m3 Water Vapor Pressure Pa Moisture Content lbs/MMscf Frost Point Oven Temperature Flow ml/min Cell Pressure External Pressure
Low	Selects the lower alarm limit for the corresponding alarm using the keypad which is opened.
Latch	Selects between latched and non-latched alarms. **Available Options:** On, Off
High	Selects the higher alarm limit for the corresponding alarm using the keypad which is opened.

Table 2 Alarm Screen Parameters

3.6.4 Calibration Screen

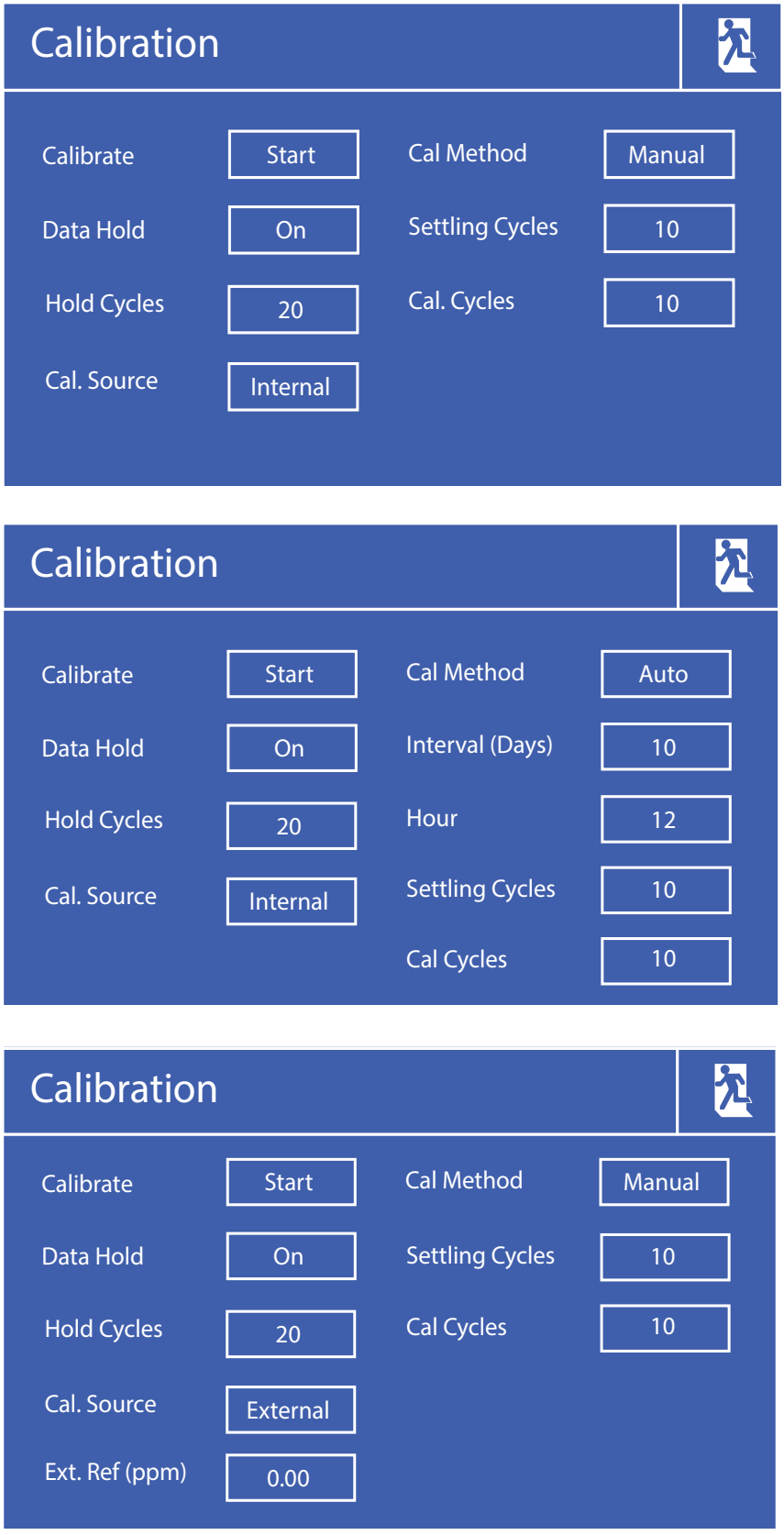


Figure 14 *Calibration Screens*

Parameter	Description	
Calibrate	Starts a calibration procedure if a manual calibration has been selected.	
Data Hold	Toggles data hold mode. This determines whether the last valid measurement is held while a calibration is carried out. **Available Options:** On, Off	
	If data hold is selected, the user can select how many cycles, after the calibration, the last measured value is held for.	
Cal Source	Toggles between an external calibration source or the internal calibration source. If an external calibration source is selected the external reference moisture must be entered in the ext ref setting. **Available Options:** External, Internal	
	External Cal Source - when this is chosen **Ext Ref** will need to be entered to show the ppm_V value of the external moisture reference.	
	Internal Cal Source - when this is chosen then the Cal Method can be set to Manual or Automatic.	
Cal Method	Toggles between manual calibration or automatic calibration mode. **Available Options:** Automatic, Manual	
	Manual Cal Method - if this is chosen the Start button must be pressed in order to initiate the calibration procedure. If this method is chosen then both the Interval and Hour selection boxes are hidden and a Start button is displayed.	
	Automatic Cal Method - if this is chosen then the following parameters will need to be set and will be displayed on the screen. Calibration will begin on the time selected using the interval and hour settings.	
	Interval (Days)	Frequency of automatic calibrations in days.
	Hour	The hour in the day at which an automatic calibration will start.
	Settling Cycles	Period of time for the QMA401 to stabilize to the new moisture level (as presented by the internal moist generator or external ppm value) before conducting the actual calibration cycles.
	Cal Cycles	Sets how many calibration cycles are carried out

Table 3 Calibration Screen Parameters

3.6.5 Monitor Screen

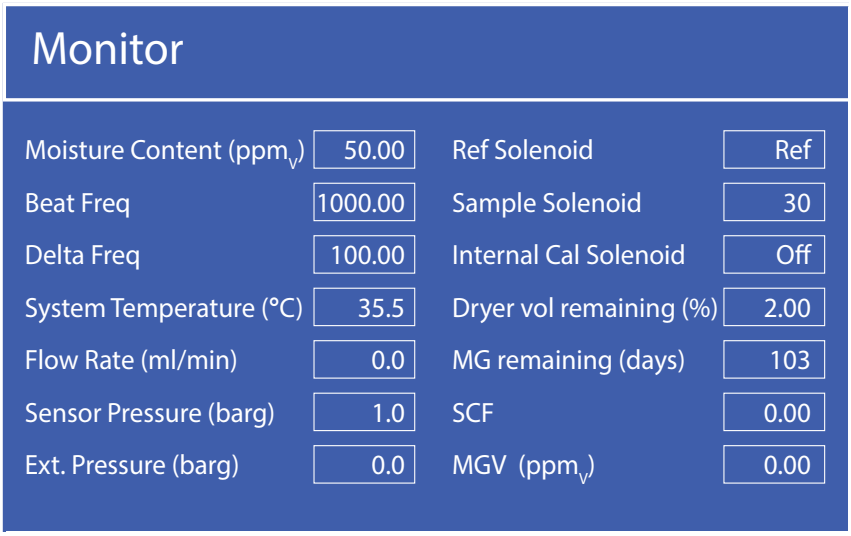


Figure 15 *Monitor Screen*

Parameter	Description
Moisture Content	Live moisture reading in ppm_V
Beat Frequency	Live beat frequency reading: the frequency difference between the two crystals
Delta Frequency	Live delta frequency reading: the frequency difference between the measurement and reference phase
System Temperature	Live system temperature
Flow Rate	Live flow rate reading in ml/min
Sensor pressure	Live sensor pressure reading
Ext pressure	Live process pressure reading
Ref Solenoid	Displays the reference solenoid state
Sample Solenoid	Displays the sample solenoid state
Internal Cal Solenoid	Displays the internal calibration solenoid state
Dryer vol remaining %	Remaining dryer lifetime in %
MG remaining (days)	Remaining moisture generator lifetime in days
SCF	Sensor correction factor set during a calibration cycle
MGV	Moisture Generator value

Table 4 Monitor Screen Parameters

3.7 Settings Menu

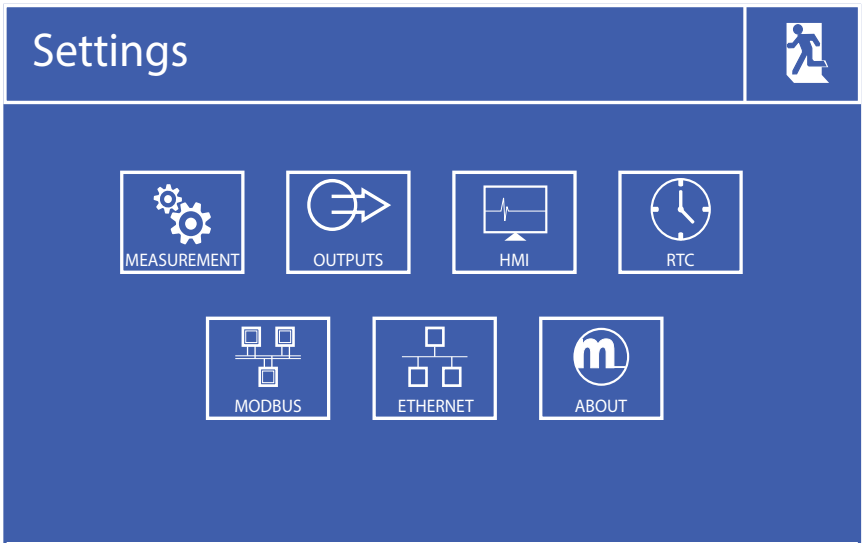


Figure 16 *Settings Menu Screen*

Allows access to the following sub menus to change instrument settings.

- Measurement
- Outputs
- HMI
- RTC
- Modbus
- Ethernet
- About

3.7.1 Measurement Screen

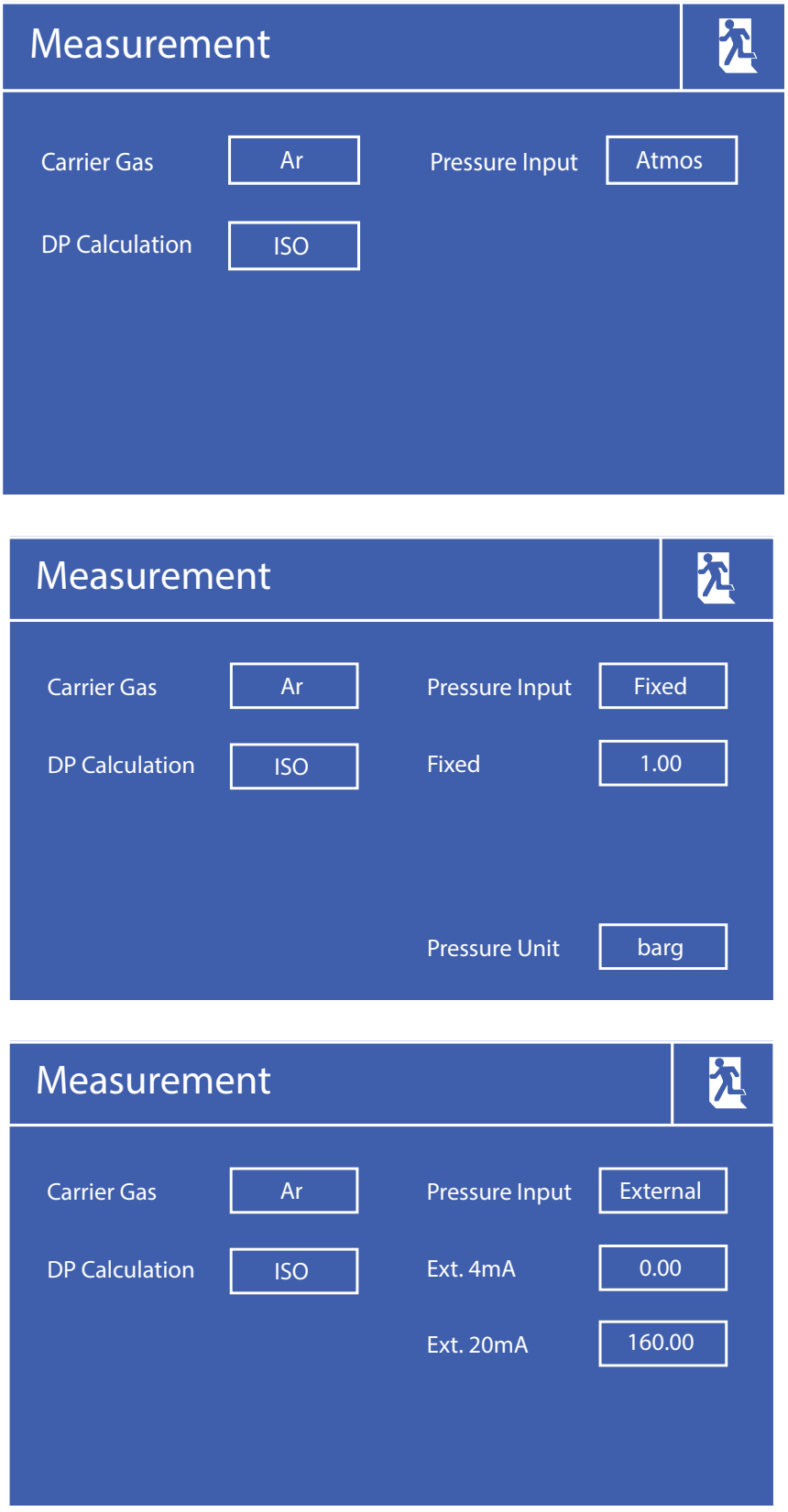


Figure 17 *Measurement Screen*

Parameter	Description
Carrier Gas	Toggles through the different carrier gas options. **Available Options:** Air, Ar, CH4, C2H2, C2H4, C2H6, C3H6, C3H8, C4H10, CO, CO2, H2, He, Kr, N2, Ne, NH3, NO, N2O, O2, Xe, User 1, User 2, User 3
	User Gas Entry: If a User option is chosen in Carrier Gas then this Parameter will show on the Measurement Page.
DP Calculation	Sets the frost point calculation method. **Available Options:** ISO (ISO 18453), Ideal Gas, IGT (IGT Bulletin #8)
Pressure Input	Selects the pressure source. **Available Options:** **Atmos** – Atmospheric pressure. **Fixed** – User-settable fixed value. When the Fixed option is chosen it enables a fixed value to be entered. **External** – An externally connected pressure transducer. When the External option is chosen it enables the choice of the zero and span range pressure transducer values of 4 or 20mA.

Table 5 Measurement Screen Parameters

3.7.2 Outputs Screen

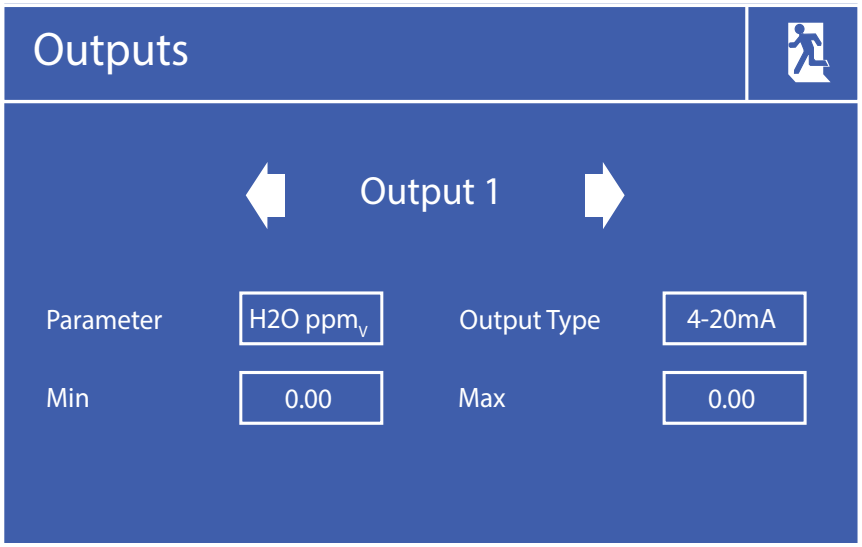


Figure 18 *Outputs Screen*

Parameter	Description
Output Selector	Selects Output required. **Available Options:** Output 1, Output 2
Parameter	Toggles through the different output parameters. **Available Options:** Oven °C, ml/min, Cell Pr. barg, External Pr. barg, H_2O ppm_V, H_2O ppm_W, H_2O mg/m^3, WVP Pa, lb/MMscf, DP °C
Output Type	Toggles the signal type of the output. **Available Options:** 1-5 V, 4-20 mA
Min	Selects the lower output limit for the corresponding output.
Max	Selects the higher output limit for the corresponding output.

Table 6 Outputs Screen Parameters

3.7.3 HMI Screen

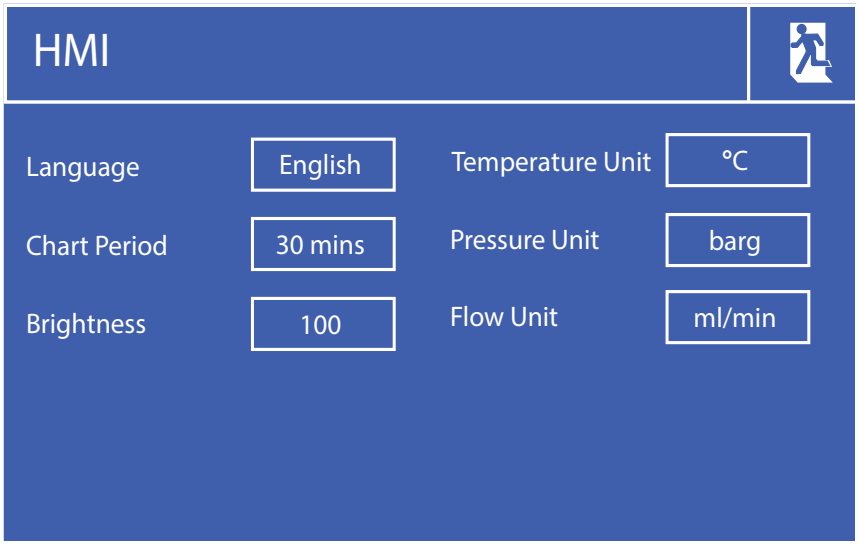


Figure 19 *HMI Screen*

Parameter	Description
Language	Toggles through the different languages available.
Chart Period	Selects the time scale of the chart. **Available Options:** 5 mins, 30 mins, 1 hr, 5 hrs, 10 hrs, 24 hrs
Brightness	Sets the screen brightness level in %. **Available Options:** 5 - 100%
Temperature Unit	Toggles through displayed temperature units. **Available Options:** °C, °F
Pressure Unit	Selects the units in which the pressure measurements are displayed. **Available Options:** barg, bara, psig, psia, MPa, mmHg
Flow Unit	Selects the flow units. **Available Options:** ml/min, sccm/min

Table 7 HMI Setup Screen Parameters

3.7.4 Real Time Clock Screen

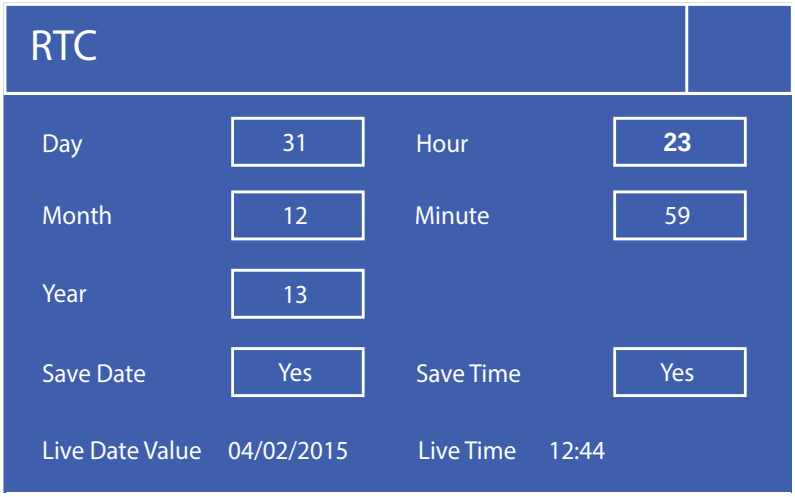


Figure 20 *Real Time Clock Screen*

Parameter	Description
Day / Month / Year	Sets the current date for the real time clock.
Hour / Minute	Sets the current time for the real time clock.
Save Date	Saves the updated date.
Save Time	Saves the updated time.

Table 8 Real Time Clock Screen Parameters

3.7.5 ModBus Screen

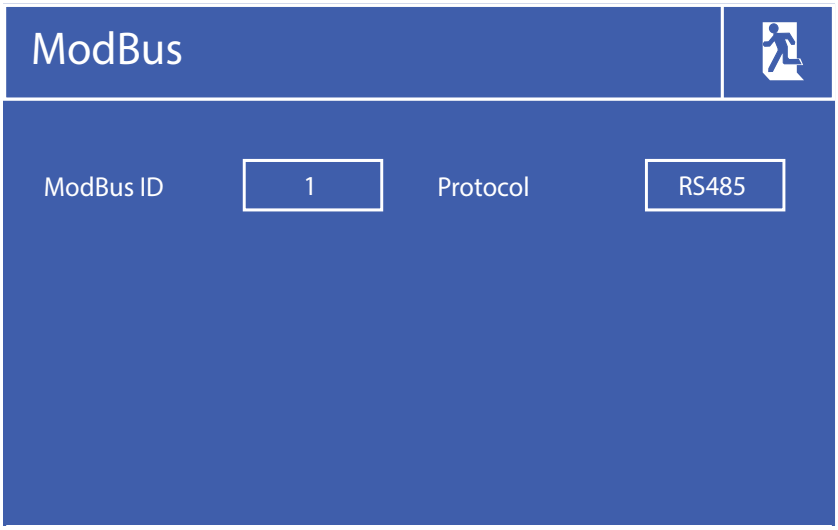


Figure 21 *ModBus Screen*

Parameter	Description
Instrument Address	Sets the instrument address using the keypad.
Protocol	Toggles different physical layer types. **Available Options: RS485 / USB / TCP/IP**

Table 9 Modbus Screen Parameters

3.7.6 Ethernet Screen

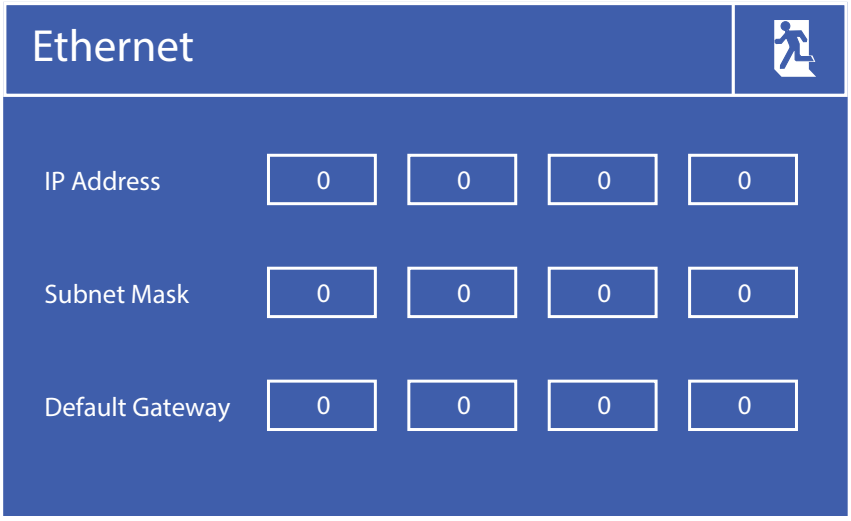


Figure 22 *Ethernet Screen*

Parameter	Description
IP Address	Instrument's static IP address on the network.
Subnet mask	Subnet mask of network that the instrument is on.
Default gateway	The default gateway of the network that the instrument is on.

Table 10 Ethernet Screen Parameters

3.7.7 About Screen

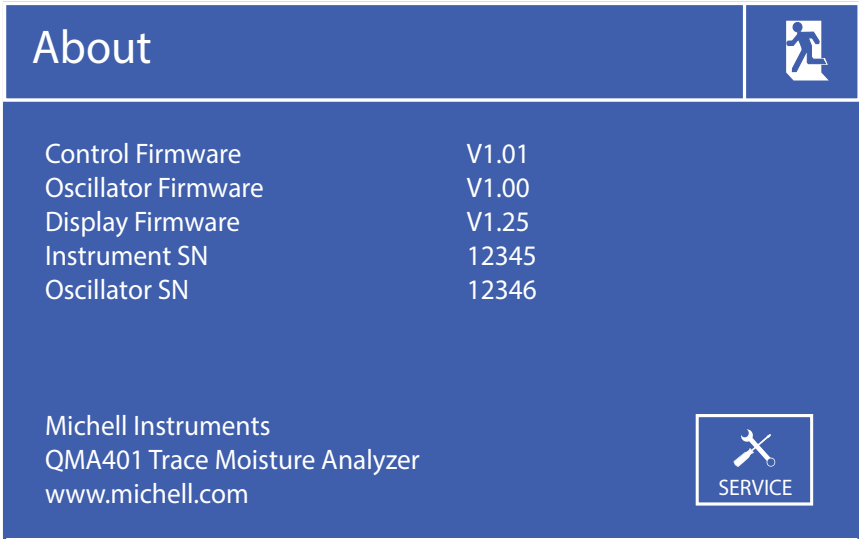


Figure 23 *About Screen*

Displays the instrument firmware versions, and serial numbers.

Service Screen

This screen is password protected and is only available to Michell authorized personnel.

To return to the Configuration Screen press the **ESC** key.

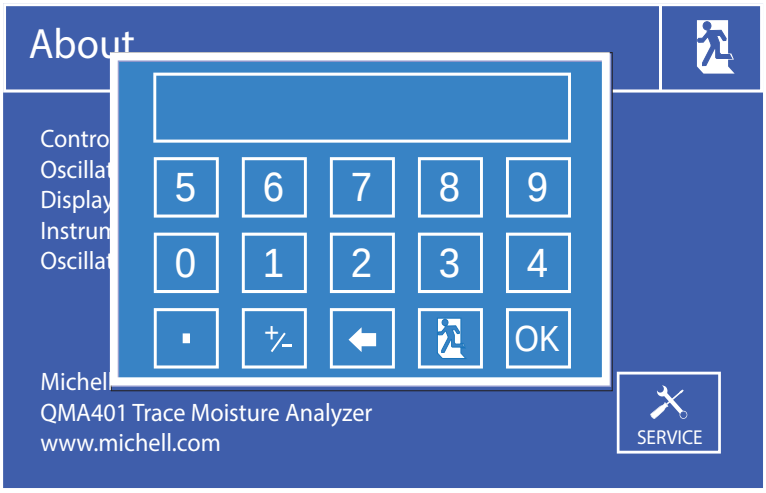


Figure 24 *Service Screen*

3.8 Sampling Guidelines

The QMA401 Trace Moisture Analyzer is designed to operate in a flowing gas stream and is suitable for the measurement of the moisture content of a wide variety of gases. In general, if the gas (in conjunction with water vapor) is not corrosive to the sampling system and the sensor base metals then it will be suitable for measurement by the QMA401.

The analyzer is designed to automatically regulate the flow rate. However, the sample pressure and back pressure must match what is shown on the calibration certificate - typically 1 barg (14.5 psig) sample pressure with the oulet at atmospheric pressure, and should be controlled using a high-quality pressure regulator on the gas inlet and a back pressure regulator on the outlet.

General guidelines to be followed when setting-up a sampling system are as follows:

- **Ensure that the sample is representative of the gas under test**

To ensure that the sample is representative of the process being monitored, the sample point should be as close to the critical measurement point as possible. Also, never sample from the bottom of a pipe where entrained liquids may be drawn into the instrument's sample input line.

- **Minimize the 'dead space' in sample lines**

Dead space in sample lines causes moisture entrapment points, increased system response times or measurement errors as the trapped moisture is released into passing sample gas, producing an increase in partial vapor pressure.

Avoid the use of too many T-pieces, in-line couplings or other unnecessary pipework. Sample pipework should, ideally, be specially designed for each application rather than adapted from that previously installed for another application. Dead space in sample lines increases response time by holding water molecules which are more slowly released to the passing gas sample.

- **Remove any particulate matter or oil from the gas sample**

Particulate matter can damage the sensors. If particulate matter, such as degraded desiccant, pipe scale and rust are likely to be present in the sample gas, use a particulate in-line filter. Michell Instruments' technical sales department can be contacted for advice.

- **Use high quality sample pipe fittings**

The sample pipework must be capable of withstanding the operating pressure of the sample line. Wherever possible, always use stainless steel pipework and fittings. This is particularly important at low dew points since other materials, e.g. nylon, have hygroscopic characteristics and adsorb moisture on the tube walls, giving rise to slower measurement response and, under certain circumstances, false dew points. For temporary applications, or where stainless steel pipework is not practicable, use high quality, thick-walled PTFE piping, which exhibits similar qualities to stainless steel.

In order to maximize response time, always use the shortest run of pipework and the smallest bore possible, taking care not to induce pressure differentials by aiming for too high a flow rate through too small a bore. Michell Instruments supplies a range of precision pressure fittings suitable for use with the QMA401 instrument. Contact Michell Instruments for details of the items available.

- **Gas samples**

Generally, if the sample gas (in conjunction with water vapor) is not corrosive to base metals, it will be suitable for measurement by the QMA401 instrument. Gases containing entrained solids should be filtered before application to the instrument.

Care should be taken with gas mixtures containing potentially condensable components in addition to water vapor, e.g. oil, to ensure that only water vapor is present in the sample. Once present on the surface of the sensors, oil will not dry out and will contaminate and damage them.

- **Material of construction**

All materials are permeable to water vapor, as the water molecule is extremely small compared to the structure of solids, even when compared to the crystalline structure of metals.

Many materials contain moisture as part of their structure, particularly organic materials, salts and anything which has small pores. It is important to ensure that the materials used are suitable for the application.

If the partial water vapor pressure exerted on the outside of a compressed air line is higher than on the inside, the atmospheric water vapor will naturally push through the porous medium against a dry air water vapor pressure. Water will migrate into the pressurized air line, this effect is called transpiration.

Over a long pipe run water will inevitably migrate into any line even through the most resistant materials. Moisture on the outlet of the line will be different than on the inlet. The best material to resist transpiration is 316L stainless steel.

It is also important to note that temperature changes can increase the tendency of these materials to affect the humidity of the surrounding air. With a given surface and gas composition, increases of line pressure and decreases in temperature increase surface adsorption.

- **Pipe material surface finish**

Components with a smooth mechanical finish are always preferred. Do not confuse the term electro-polished with a mechanical polishing procedure. Electro-polishing normally is preceded by mechanical polishing to achieve the best results. If a choice of finish is available for the materials dictated by the process or sample system, select the smoothest for faster response.

- **Pipe diameter**

The larger the sampling pipe diameter, the more exposed the gas will be to the pipe wall. Therefore it is recommended to use the smallest possible pipe diameter to minimize the previously mentioned effects. This must be balance with the desired response speed. Depending on the configuration 1/8" pipe diameter is recommended. Please contact Michell Instruments if further recommendations are needed.

- **Ambient temperature variation**

The QMA401 is extremely sensitive to moisture fluctuations and ambient temperature variations will affect the equilibrium conditions. In a stable environment, the water vapor pressure within a closed system is in equilibrium with the outside ambient. If the ambient temperature increases, the energy is imparted to the gas pipes and the water molecules within the wall. This additional energy will upset the original equilibrium and the increased pressure water in the walls migrates in towards the drier gas stream.

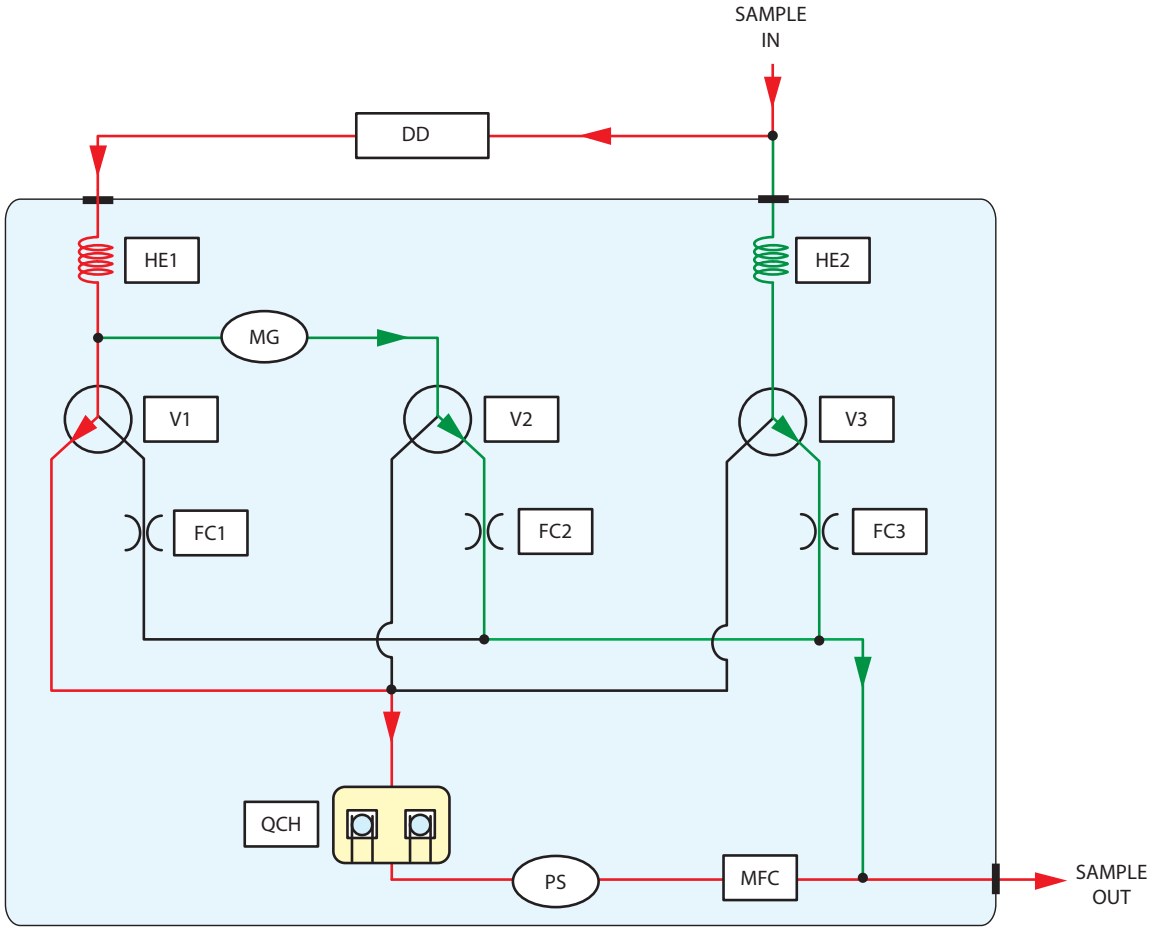
Small molecules such as water will migrate through the pipe wall until the entire system reaches a new equilibrium. It is possible to minimize this effect on a sampling system by heat tracing sample lines and insulating/heating the sampling system enclosure to a stable temperature above the maximal ambient temperature.

It is important to control the temperature of all components of the sampling system, including regulators and lines. For this reason it is strongly advised to use heat traced line to eliminate this temperature change effect and measure moisture content solely related to the gas under test.

3.9 Measurement Cycle

At the beginning of a measurement cycle V1 is energized. This allows the dried sample gas to be routed to the sensor cell for a period of 30 seconds as shown by the red line in *Figure 25*. During this first phase of the measurement cycle the frequency difference between the sensor and reference crystals is measured (i.e. dry state).

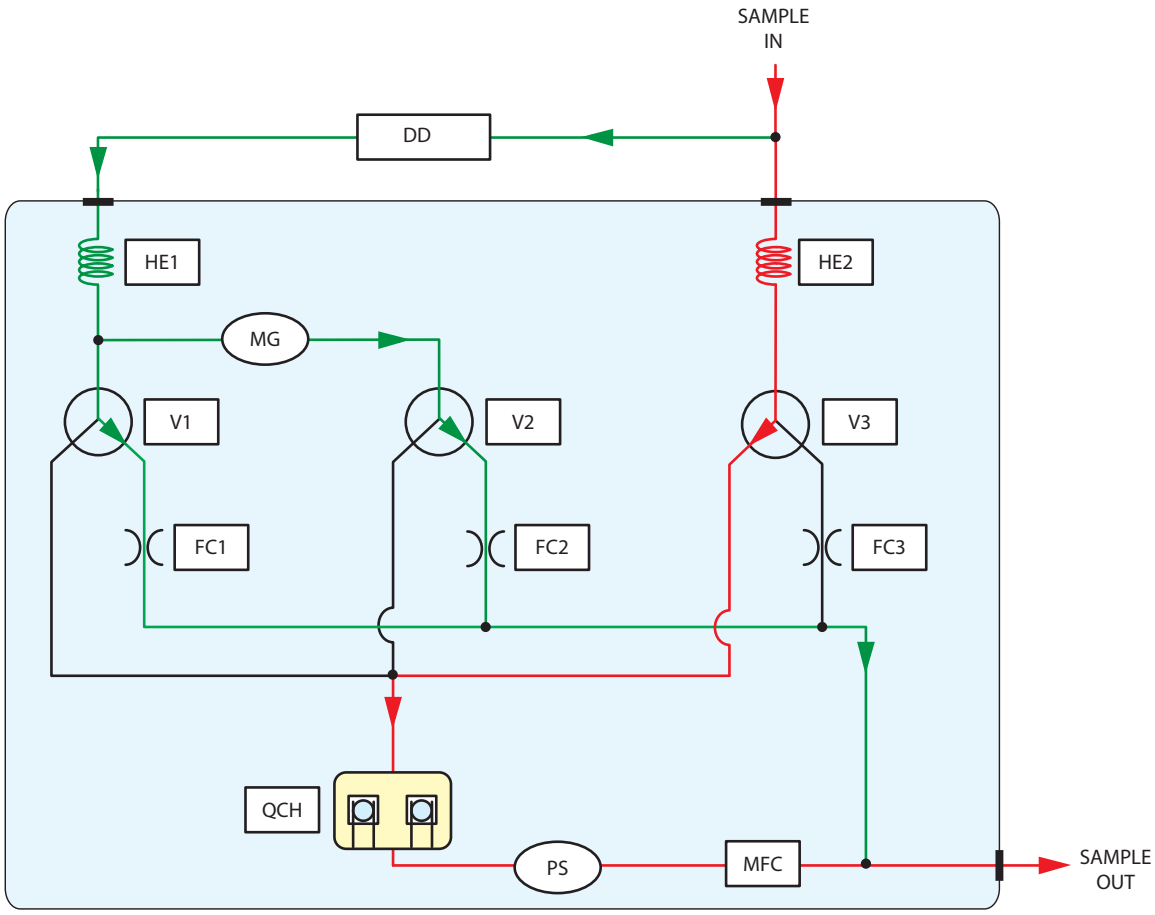
The sample and calibration gas paths are shown in green. These lines are continually purged during the initial measurement cycle.



Key			
DD	Desiccant column	**MG**	Moisture generator
MFC	Mass flow controller	**V1, V2, V3**	Solenoid Valves
QCH	Sensor cell	**HE1, HE2**	Heat exchanger
PS	Pressure sensor	**FC1, FC2, FC3**	Flow control

Figure 25 *Measurement Cycle (Phase 1) - Dried Sample Flow*

After a 30 second sampling period, V1 is de-energized. This cuts off the dried gas supply to the sensor cell and V3 is energized connecting the sample gas (red line - see *Figure 26)* to the sensor cell for a further period of 30 seconds. The reference and sample gas paths are shown in green. These lines are continually purged during this second phase of the measurement cycle.



Key			
DD	Desiccant column	**MG**	Moisture generator
MFC	Mass flow controller	**V1, V2, V3**	Solenoid Valves
QCH	Sensor cell	**HE1, HE2**	Heat exchanger
PS	Pressure sensor	**FC1, FC2, FC3**	Flow control

Figure 26 *Measurement Cycle (Phase 2) Calibration Flow*

During this second phase of the measurement cycle the frequency difference between the reference and sensor crystals is measured again (i.e. wet state). After signal processing the measured difference in frequency between the wet and dry phases is proportional to the moisture content of the sample gas.

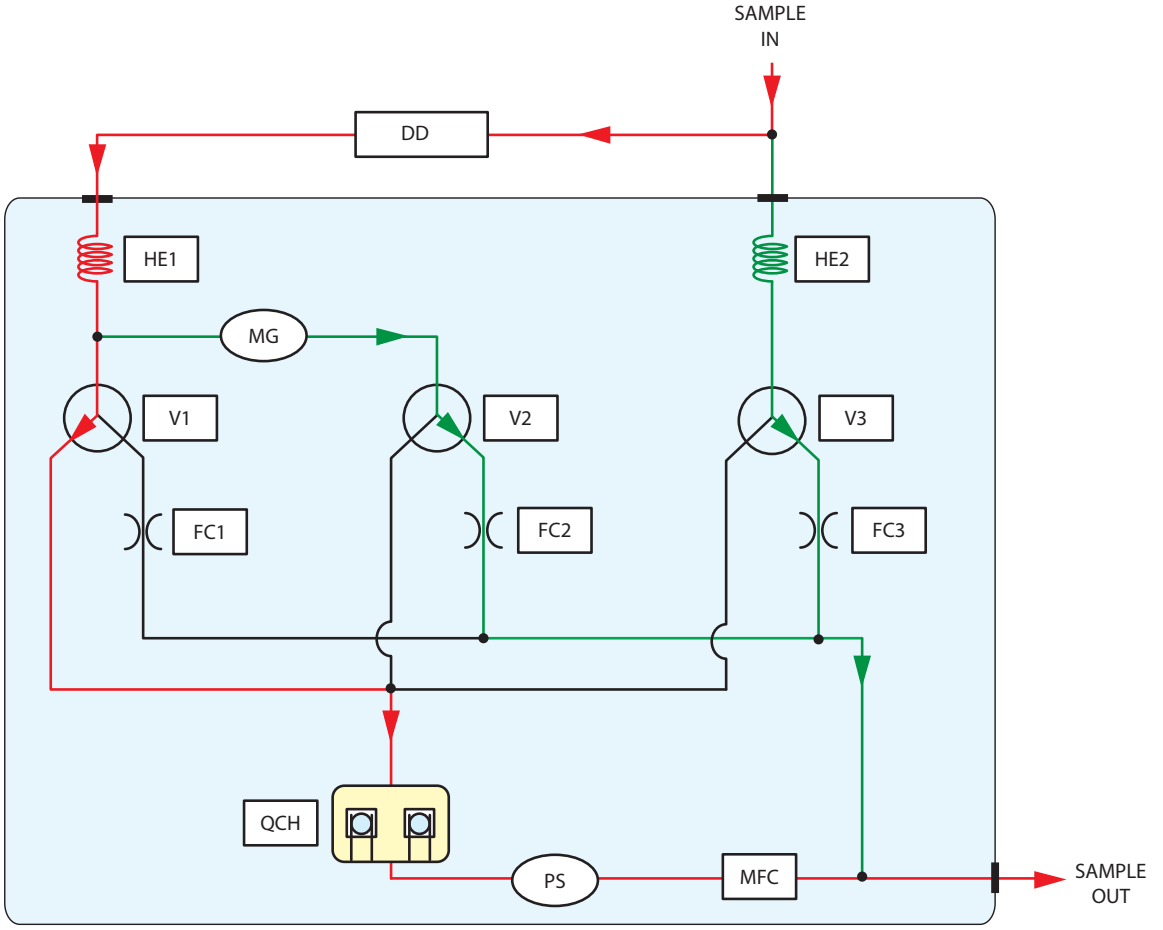
3.10 Calibration Cycle

To maintain the precision of the analyzer, the unit can self calibrate and adjust its internal reference table based on the result.

This is achieved as follows:

An internal moisture generator uses a permeation tube to generate a nominal moisture content of 0.5, 5 or 50 ppm_V, depending on what was specified at the time of order.

The calibration is carried out in a two phase cycle. Initially V1 is energized, causing the dried sample gas to be routed to the sensor cell for a period of 30 seconds, as shown by the red line in *Figure 27.*



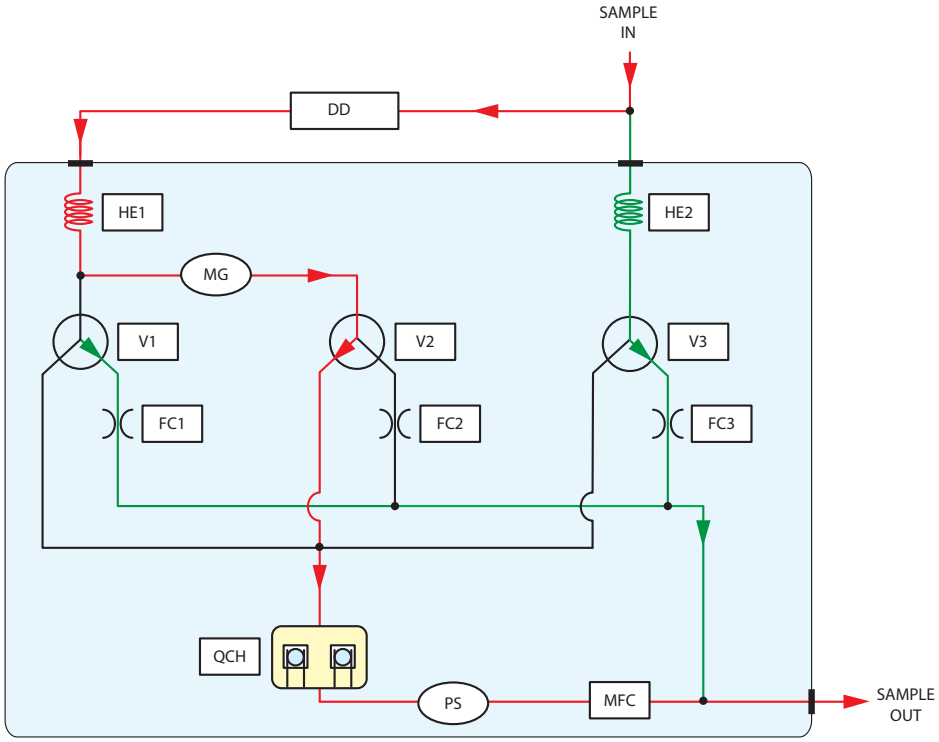
Key			
DD	Desiccant column	**MG**	Moisture generator
MFC	Mass flow controller	**V1, V2, V3**	Solenoid Valves
QCH	Sensor cell	**HE1, HE2**	Heat exchanger
PS	Pressure sensor	**FC1, FC2, FC3**	Flow control

Figure 27 *Calibration Cycle (Phase 1) - Dried Sample Flow*

At the close of this 30 second sampling period, V1 is de-energized, and V2 is energized; so that the reference gas from the moisture generator is now routed to the sensor cell. This is the beginning of phase 2, see *Figure 28.*

The calibration reference gas is measured for a further 30 seconds, until V2 is de-energized and the cycle begins again.

The inactive sample paths are continually purged during each phase (see green flow paths on *Figures 25 and 26)*.



Key			
DD	Desiccant column	**MG**	Moisture generator
MFC	Mass flow controller	**V1, V2, V3**	Solenoid Valves
QCH	Sensor cell	**HE1, HE2**	Heat exchanger
PS	Pressure sensor	**FC1, FC2, FC3**	Flow control

Figure 28 *Calibration Cycle (Phase 2) - Sample Flow*

The analyzer will run though a number of 'settling cycles' to ensure the internal sample system is fully equilibrated with the calibration gas before beginning to collect calibration data.

After the system has carried out the selected number of settling cycles, it begins the calibration cycles. During these cycles, the difference between the calibration reference gas and the dried gas is measured. As the moisture content of the calibration gas is known, the difference between this and the measured value is equal to the error in the system.

The QMA401 stores this measured calibration value and automatically compensates subsequent sample readings for any offset that may have occurred to the factory calibration curve.

4 MAINTENANCE

Gas line connections to the measurement system must be isolated and de-pressurized before any work commences.

Any loose or disturbed pipework or couplings must be leak tested.

The design of the QMA401 and measurement system is such that minimal maintenance is required. However, if a fault does occur with the system that is not covered within this manual please contact Michell Instruments (see contact information at www.michell.com) or your local representative.

Any maintenance of this product should only be conducted by suitably trained personnel. Any unauthorized maintenance of this product not covered by this manual could invalidate the product warranty.

In addition to general maintenance procedures which involve the cleaning of the instrument's casing and display, the desiccant column can be removed and replaced by the operator.

4.1 Removal and Replacement of the Power Supply Fuse

The fuse can be serviced in the field by an approved Michell Instruments' service technician. Please consult your Michell service representative for spare or replacement parts.

4.2 Removal and Replacement of the Desiccant Column

1. Undo thumbscrews to remove dryer access panel.

2. Remove supplied spanner/wrench from the mount on the dryer access panel.

3. Loosen the VCR fittings on the dryer assembly using the supplied spanner/ wrench.

4. Disconnect the VCR fittings by hand.

5. Remove dryer assembly.

6. Fit replacement dryer assembly, following these instructions in reverse to re-assemble.

5 CALIBRATION

5.1 Traceability

The calibration of this analyzer is traceable to national standards. For this reason the analyzer can only be calibrated in an accredited e.g. NPL (UK) or NIST (US) standards laboratory.

If these facilities are not available the analyzer must be returned to the manufacturer, Michell Instruments, or one of their approved agents. A list of worldwide Michell Instruments' offices is provided at www.michell.com.

The analyzer is calibrated at a fixed pressure over the sensing crystals, and the analyzer's calibration is only valid while the inlet pressure and back pressures have been set correctly.

The Auto function can be disabled for calibration purposes (see Section 3.6.4).

A calibration certificate bearing a nine point calibration is issued with each analyzer. If required, an option is available to add further specific calibration points by contacting Michell Instruments. A list of worldwide Michell Instruments' offices is provided at www.michell.com.

Figure 29 shows a typical calibration certificate.

CERTIFICATE OF CALIBRATION

QMA401

MICHELL Instruments

The under-mentioned item has been calibrated at the following points in the Michell Instruments' Humidity Calibration Laboratory against Test Equipment traceable to the NATIONAL PHYSICAL LABORATORY, Middlesex, United Kingdom and to the NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY, Gaithersburg, Maryland, USA.

Certificate Number	50585	*Analyzer Serial Number*	129247
Test Date	3/09/2015	*Test Equipment*	Q0224
Acknowledgement Number	T23099		
Sensor Serial Number	0027	*Calibration Temperature (°C)*	21
Ref Crystal Serial Number	0100	*Mean gas flow (ml/min)*	99.95
Sensor Crystal Serial Number	0060	*Primary delta f (Hz)*	8564.14
		MG Moisture Level (ppm)	7.5

Reference (ppm)	Measured Moisture Content (ppm)
0.350	0.365
1.517	1.530
5.809	5.542
19.111	17.743
62.513	58.251
120.40	111.76
221.00	204.52
391.09	362.88
671.30	630.64

Comments: N/A

Approved Signatory : *Date:* 3/09/2015

Michell Instruments Ltd.
www.michell.com

Figure 29 *Typical QMA401 Calibration Certificate*

6 APPLICATION SOFTWARE OVERVIEW

With the QMA Application Software you can:

- Read and edit all main analyzer parameters
- Chart and log all main analyzer parameters
- Perform a calibration
- Reset the analyzer to factory defaults

Communication between the application software and analyzer is via Modbus RTU over RS485.

6.1 System Requirements

For the best software performance, the host computer should meet the following minimum requirements:

O/S	Windows XP, Windows VISTA, Windows 7 (32-bit or 64-bit), Windows 8 (32-bit or 64-bit)
CPU	Intel Pentium III 500 MHz (recommended: Pentium 4 1.6 GHz or Pentium M 1.0 GHz, or Athlon 1.2 GHz or higher)
RAM	512 MB (recommended: 1.0 GB)
Disk space	Application = 3 MB

6.2 System Connection

If using an RS485 connection - connect the communications cable and RS485 to RS232 converter to a spare serial port or serial to USB adaptor on the host computer.

If using USB - connect the analyzer directly to the host computer using a USB cable after installing the application software.

If using Modbus TCP - connect the analyzer to a LAN using an Ethernet cable.

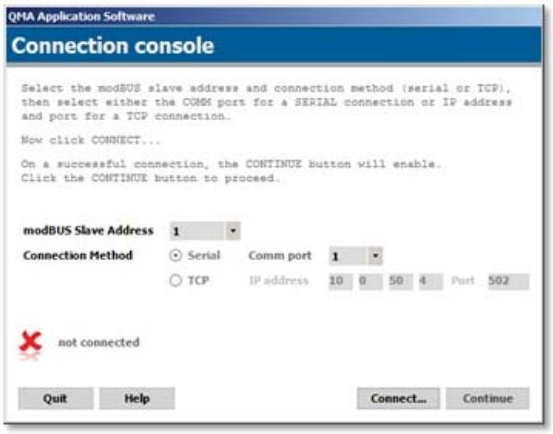
For information the default serial settings are:

Baud 9600
Parity NONE
Data bits 8
Stop bits 1

6.3 Getting Started

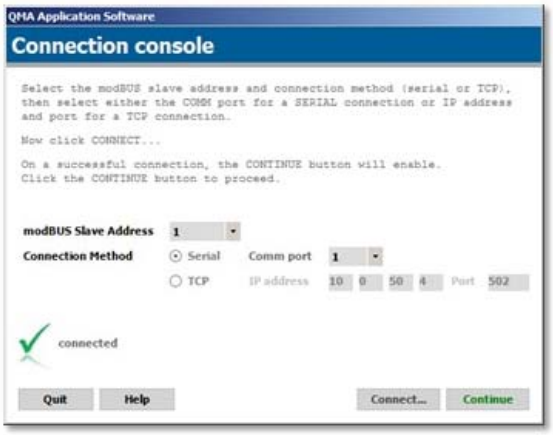
On launching the software the connection console will appear, allowing you to establish communications between the software and QMA analyzer.

Choose the Modbus slave address (default is 1) and the serial COM port that the instrument is connected to. **(NOTE: TCP is not supported in this instrument)**.



Click the 'Connect...' button.

After a few seconds the software will report a successful connection or not. If the connection is successful, the word 'Connected' and a green tick will appear.



Click the 'Continue' button to continue onto the main acquisition window.

6.3.1 Connection Method (Serial Connection (RS485 or USB)

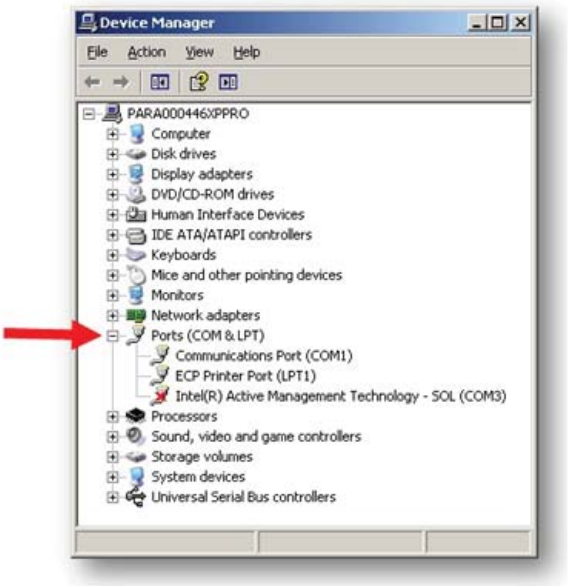
Select the COM port to which the analyzer is connected.

6.3.1.1 RS485 Connection

An RS485 to RS232 converter must be used when connecting to a computer's built in serial port, or when connecting to a RS232 to USB adaptor.

To find the COM port number of assigned to a USB to RS232 adapter, open Windows 'device manager' and expand the 'Ports (COM & LPT)' branch.

The USB to RS232 adapter should be listed in this branch, together with the COM port number.



6.3.1.2 USB Connection

If directly connecting via USB, the analyzer will appear in Device Manager as a virtual serial port with the name 'Michell Instruments USB to UART Bridge Controller', followed by its assigned COM port number, e.g. COM3.

6.3.1.3 Modbus TCP Connection (Ethernet)

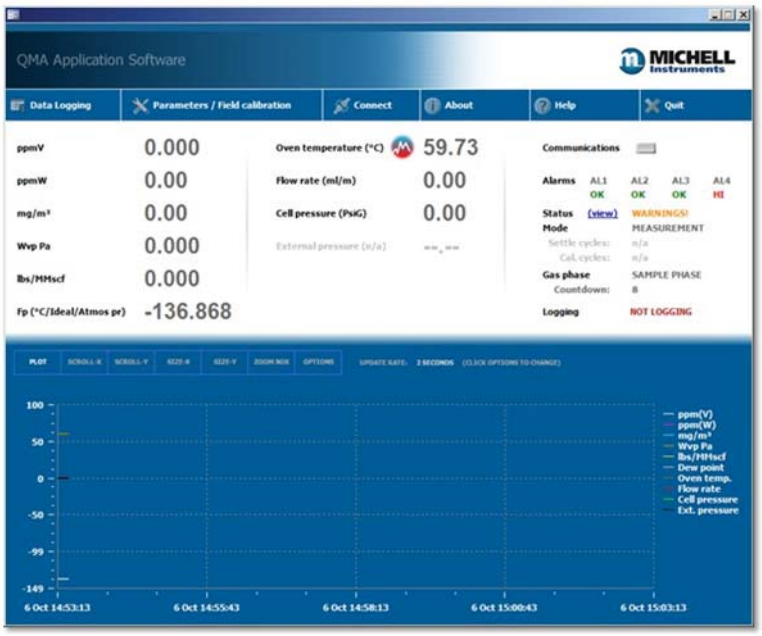
Enter the IP address and port number of the analyzer.

6.4 Main Window

The application software will automatically begin acquiring, displaying and charting data from the analyzer once a connection has been established.

Data acquisition occurs approximately every 2 seconds. The chart update rate is 2 seconds but this may be changed by using the chart options window.

Data logging does not start automatically, this is indicated by the text 'NOT LOGGING' on the Main Screen. Click the 'Data Logging' button to launch the data logging setup window.



To configure analyzer parameters, click the 'Parameters / Field calibration' button to launch the parameters window.

Click the 'Connect' button to re-connect with the analyzer or connect with a new analyzer.

6.5 Using the Chart

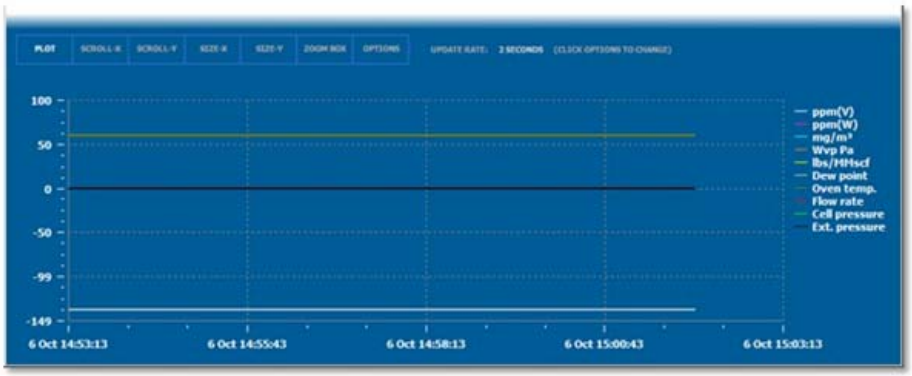
Chart mode buttons

The chart defaults to plot mode.

To change the chart mode, click one of the buttons along the top of the chart, described below.

Function	Description
PLOT	Puts chart into live plot mode
SCROLL-X	Allows the user to scroll the X-axis left and right
SCROLL-Y	Allows the user to scroll the Y-axis up and down
SIZE-X	Allows the user to size the X-axis
SIZE-Y	Allows the user to size the Y-axis
ZOOM BOX	Allows the user to draw a box in the data area which will zoom in on the data within the box. The box is drawn from top-left to bottom-right
OPTIONS	Invokes the chart options window

After using the scroll. size or zoom modes, changing the chart back to plot mode resets the X and Y axes.



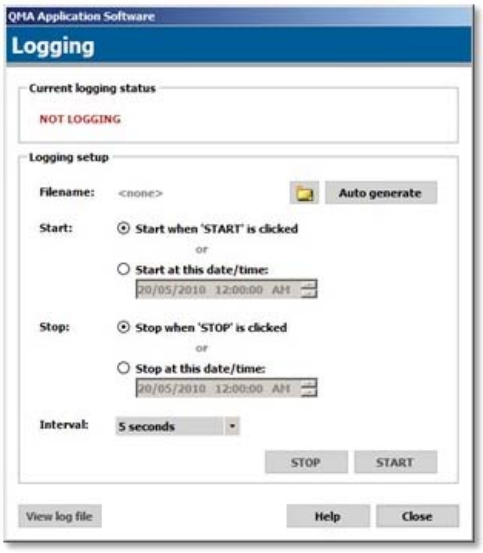
6.5.1 Chart Options Window

The Chart Options Window allows the user to configure the following chart properties:

Function	Description
Show/hide series	Allows the user to show or hide data series from the chart. Tick to show, untick to hide
Restore on plot mode	When ticked, selecting plot mode will restore the X and Y axis to the state before they were modified (after sizing, zooming or scrolling)
Y-axis scale	Select either 'autoscale all data' or 'manual scaling' of the Y-axis. Selecting manual scaling will show a min and max input text box
Update rate	Allows the user change the update rate of the chart
Reset chart	Clears all chart data

6.6 Data Logging

Click the 'Data Logging' button on the Main Window to launch the Data Logging Setup Window.



Choosing a log file filename

Choose a log file manually by clicking the button.

Click the 'Auto generate' button to generate a filename based on the current date and time.

An auto generated log file filename has the following format:

QMA dd-mm-yy hh:mm:ss.log

- where dd = date, mm = month, yy = year, hh = hour (24 hr), mm = minutes and ss = seconds

Example:

QMA 15-12-14 13.41.55.log

which is 15th December 2014 at 1.41.55 pm

Auto generated log files are stored in the local My Documents folder

C:\Users\username\Documents\
C:\Documents and Settings\username\Documents\

6.6.1 Configuring Logging Start Time

Logging may be started immediately or at a user-defined time in the future.

To start logging immediately, select the 'Start when **START** is clicked' option.

To start logging at a user-defined time in the future, select the 'Start at this date/time:' option and enter the date and time when you wish to start logging.

6.6.2 Configuring Logging Stop Time

If the 'Stop when **STOP** is clicked' option is selected, then the software will continue logging indefinitely until either the 'STOP' button is clicked or the software is shut down.

If the 'Stop at this date/time:' option is selected then the software will continue logging until the selected date and time is reached or when the 'STOP' button is clicked or the software is shut down.

6.6.3 Starting the Log

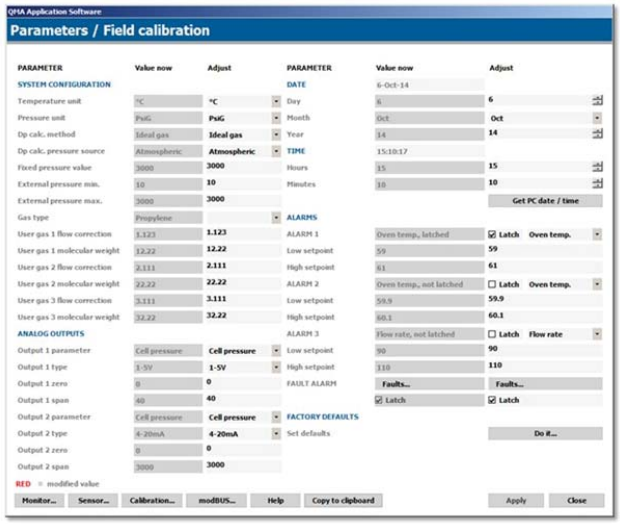
After choosing a filename and configuring logging start and stop times, click the 'START' button.

6.6.4 Viewing a Log

Click the 'view log file' button to view a log file within Windows notepad.

6.7 Parameters / Field Calibration

Analyzer parameters may be viewed and edited via this window.



Current (live) values are shown in the 'Value now' column. New values may be entered in the 'Adjust' column. When a value is modified it will be shown in red and the 'Apply' button will enable.

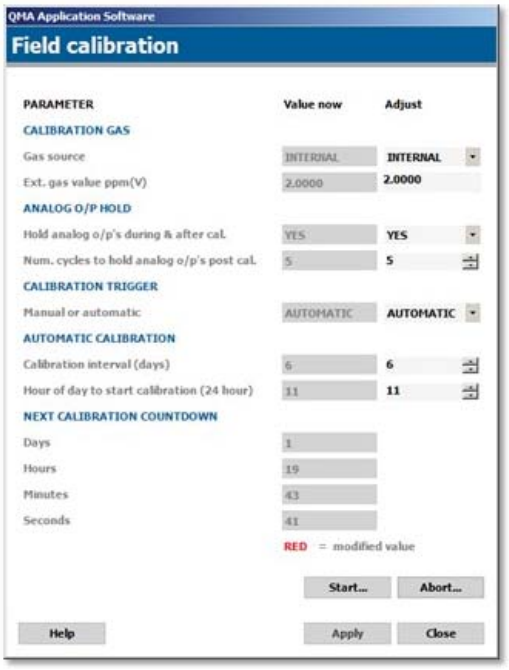
Click the 'Apply' button to apply the modified values to the analyzer.

To write the PC date and time to the analyzer, first click the 'Get PC date/time' button to load the values into their respective positions on the screen, then click the 'Apply' button.

To reset the analyzer to factory defaults, press the 'Do it...' button under the Factory Defaults heading.

6.7.1 Field Calibration

This window allows manual analyzer calibrations to be performed, and settings for automatic calibrations configured.



7 SHIPPING

7.1 Preparation for Shipping and Packing

For shipping purposes, the instrument should be packed into its original carton, the latter providing the recommended degree of protection during transit.

To prepare the instrument for shipping, proceed as follows:

1. Switch off the instrument, isolate the power supply and remove the power supply cable.
2. Remove the analog connector and alarm output connectors.
3. Isolate the incoming sample line and remove the connections to the GAS IN and GAS OUT ports.
4. Pack the instrument in its original case by first fitting the end packing, and lowering the instrument into the carton. Place any accessories being returned in the accessories box and place in the carton last.
5. Create a packing list detailing all equipment contained in the box, place it inside the box and seal the box. Ideally, for extra security, the box should be banded.

Appendix A

Technical Specifications

Appendix A Technical Specification

Performance	
Measurement Technology	Fast Response Quartz Crystal Microbalance
Range	Calibrated range 0.1 - 700 ppm_V Indication to 2000 ppm_V
Accuracy	±10% of reading from 1 to 2000 ppm_V ±0.1 ppm_V between 0.1 & 1 ppm_V
Repeatability	±5% of the reading from 1 to 2000 ppm_V ±0.1 ppm_V between 0.1 & 1 ppm_V
Detection Limit	0.1 ppm_V
Available Units	ppm_V, ppm_W, mg/Nm^3, vapor pressure (Pa), frost point (°C), lbs/MMscf
Response Speed	T63 <2 mins to step change in either direction T95 <5 mins to step change in either direction
Self Verification	Internal moisture generator source calibrated traceable to NPL & NIST
Sensitivity	0.1ppm_V or 1% of reading, whichever is greater
Electrical Specifications	
Supply Voltage	85 to 264 V AC, 47/63Hz, 110 to 300 V DC
Alarms	1 x System Alarm, volt-free change-over (FORM C) 3 x process alarms, selectable for various parameters, volt free change-over (FORM C)
Communications	Analog Outputs: 2 channels, user selectable 4-20 mA or 1 to 5 V Digital Communications: RS485/USB Modbus RTU, Ethernet Modbus TCP
Data logging	Logging to SD card at user-selectable interval
Local Interface	7" color touch screen LCD
Operating Conditions	
Inlet Pressure	1 barg (14.5 psig)
Outlet Pressure	Atmospheric
Sample Flow	300ml/min total flow without bypass
Sample Gas Temperature	0 to +100°C
Operating Environment	+5 to +45°C (+41 to +113°F) up to 90% RH
Mechanical Specifications	
Enclosure	19" Rackmount, 4U x 434mm
Gas Connections	1/4" VCR(M)
Weight	13.5 kg (29.8 lbs)

Appendix B

Modbus Register Map

Appendix B Modbus Holding Register Map

All the data values relating to the QMA401 Trace Moisture Analyzer are stored in holding registers. Each of these registers is two bytes (16-bits wide). Some of these registers contain instrument specific values e.g. its own unique system address, IP address values, etc. Others registers hold specific real time data e.g. measured dew-point and temperature.

Each Modbus message has a two part address code, one for the low byte (bits 0 through 7) and one for the high byte (bits 8 through 15). The facility exists for multiple registers, specified by a high and low byte contained in the query message, to be addressed and read by the same message.

The table below describes the instruments' registers with their respective address locations, together with their relevant register configurations and register map definitions. **Note: Hexadecimal (Hex) addresses marked with an asterisk denote instrument specific parameters stored in the instrument's flash memory.**

The register maps below the table define the data allocated to each bit/byte for each register type.

Address #	Function Description	Read/ Write	Default	Register Config	Notes/ Real Value Range
0	ModBus Configuration	R/W		C	
1	System Configuration	R/W		D	
2	Alarm Configuration	R/W		E	
3	Analog Output Configuration	R/W		F	
4	Internal Logging Configuration	R/W		U	
5	MFC Span in mlm / Gas Number for flow rate and mol weight correction	R/W		S	
6-8	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
9	Fault Relay Alarm fault selection mask	R/W		M	
10	Dryer Capacity (ppm) / Moist Gen Capacity (days)	R/W	255 / 103	V	
11	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
12	Alarm1 – Low Set point	R/W		See Appendix B1	
13	Alarm1 – High Set point	R/W		See Appendix B1	
14	Alarm2 – Low Set point	R/W		See Appendix B1	
15	Alarm2 – High Set point	R/W		See Appendix B1	
16	Alarm3 – Low Set point	R/W		See Appendix B1	
17	Alarm3 – High Set point	R/W		See Appendix B1	
18	Analog Out 1 – Low Set point	R/W		See Appendix B1	
19	Analog Out 1 – High Set point	R/W		See Appendix B1	
20	Analog Out 2 – Low Set point	R/W		See Appendix B1	

21	Analog Out 2 – High Set point	R/W		See Appendix B1	
22	Fixed Pressure Input Value	R/W		See Appendix B1	
23	Next Calibration – Configuration	R/W		P1	
24	User low ppmV limit	R/W		A3	0.00 to 0.10
25	Next Calibration – Intervals between cal	R/W		P2	
26	Next Calibration – External Cal Val – Hi Word	R/W		I	0.01 to 2000.00 ppmv
27	Next Calibration – External Cal Val – Lo Word	R/W		I	0.01 to 2000 .00ppmv
28	Last Cal Day/Month/Year	R		J	
29	Last Cal Details (can write correction factor)	R/W		K	
30	Last Cal -1 Day/Month/Year	R		J	
31	Last Cal -1 Details	R		K	
32	Last Cal Date – 2 Day/Month/ Year	R		J	
33	Last Cal Details – 2 Details	R		K	
34	Last Cal Date -3 Day/Month/ Year	R		J	
35	Last Cal Details – 3 Details	R		K	
36	Last Cal Date -4 Day/Month/ Year	R		J	
37	Last Cal Details – 4 Details	R		K	
38	User Gas Flow Correction Val1	R/W		A4	0.100 to 10.000
39	User Gas Flow Correction Val2	R/W		A4	0.100 to 10.000
40	User Gas Flow Correction Val3	R/W		A4	0.100 to 10.000
41	User Gas Mol Weight Val1	R/W		A3	0.10 to 500.00
42	User Gas Mol Weight Val2	R/W		A3	0.100 to 500.00
43	User Gas Mol Weight Val3	R/W		A3	0.100 to 500.00
44	Ext (line) Pressure Sensor Min	R/W		See Appendix B1	
45	Ext (line) Pressure Sensor Max	R/W		See Appendix B1	
46-56	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
57	*Instrument Serial Number HI WORD	R/W		32 bit Integer HI Word	1 to 4294967296
58	*Instrument Serial Number LO WORD	R/W		32 bit Integer LO Word	"
59	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
60	*Osc FW Version Hi Word	R		I	
61	*Osc FW Version Lo Word	R		I	
62-185	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
186	*Osc Serial Number HI WORD	R/W		32 bit Integer HI Word	1 to 4294967296
187	*Osc Serial Number LO WORD	R/W		32 bit Integer LO Word	"

188-194	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
195	Passcode for protected registers	W		A1	(NOT USED CURRENTLY)
196	RTC Set Hours/Mins	W		H	Write to set Time
197	RTC Set Day/Month/Year	W		J	Write to set Date
198	Instrument Command Register	W		T	
199	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
200	Main Board f/w version	R		A3	
201	Moisture – PPMv – Hi Word	R		I	
202	Moisture – PPMv – Lo Word	R		I	
203	Moisture – PPMw – Hi Word	R		I	
204	Moisture – PPMw – Lo Word	R		I	
205	Moisture – mg/m3 – Hi Word	R		I	
206	Moisture – mg/m3 – Lo Word	R		I	
207	Moisture – Pa – Hi Word	R		I	
208	Moisture – Pa – Lo Word	R		I	
209	Moisture – lb/mmscf – Hi Word	R		I	
210	Moisture – lb/mmscf – Lo Word	R		I	
211	Dew point Hi Word in set unit	R		I	
212	Dew point Lo Word in set unit	R		I	
213	Enclosure Temperature in set unit	R		B2	
214	Ext Pressure Reading in set unit	R		See Appendix B1	
215	DeltaF Hi Word	R		I	
216	DeltaF Lo Word	R		I	
217	Beat Frequency Hi Word	R		I	
218	Beat Frequency Lo Word	R		I	
219	Oven Temperature in set unit	R		B3	
220	Flow Rate in ml/m	R		A2	
221	Heater Power in %	R		A2	
222	RTC Hours/Minutes	R		H	
223	RTC Seconds	R		A1	
224	RTC Day/Month/Year	R		J	
225	Ref Seconds / Sample Seconds Countdown	R		Q	
226	Pressure Reading of cell in set unit	R		See Appendix B1	

227	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
228	Cal Settling / Calibration Cycles Countdown	R		Q	
229	System Status Register	R		L	
230	Warning Flags Register	R		M	
231	Current Flow Correction value	R		A4	
232	Moist Gen Value Read After Cal – Hi Word	R		I	For cal use
233	Moist Gen Value Read After Cal – Lo Word	R		I	For cal use
234	Countdown to Next Cal HHDD	R		P2	
235	Countdown to Next Cal MMSS	R		Q	
236	10 Sample Averaged DeltaF Hi Word	R		I	Average of 10 deltaF Logs - For cal use
237	10 Sampled Averaged DeltaF Lo Word	R		I	"
238	10 Sample Averaged Ppmv Hi Word	R		I	Average of 10 ppmv Logs - For cal use
239	10 Sampled Averaged Ppmv Lo Word	R		I	"
240	Oven Temperature Live Averaged ADC Val	R		A1	
241	Internal Pressure Live Averaged ADC Val	R		A1	
242	External Pressure Live Averaged ADC Val	R		A1	
243	Dryer Capacity Used / Moist Gen Capacity Used	R		V	
244	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
245	Ethernet Settings – IP Address – Upper Bytes	R/W		Q	Volatile – Cannot write via Modbus, only via display
246	Ethernet Settings – IP Address – Lower Bytes	R/W		Q	"
247	Ethernet Settings – Subnet Mask – Upper Bytes	R/W		Q	"
248	Ethernet Settings – Subnet Mask – Lower Bytes	R/W		Q	"
249	Ethernet Settings – Def Gateway – Upper Bytes	R/W		Q	"
250	Ethernet Settings – Def Gateway – Lower Bytes	R/W		Q	"
251	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
252	DeltaF Log t0 Hi Word	R		I	For cal use

253	DeltaF Log t0 Lo Word	R		I	For cal use
254	DeltaF Log t1 Hi Word	R		I	For cal use
255	DeltaF Log t1 Lo Word	R		I	For cal use
256	DeltaF Log t2 Hi Word	R		I	For cal use
257	DeltaF Log t2 Lo Word	R		I	For cal use
258	DeltaF Log t3 Hi Word	R		I	For cal use
259	DeltaF Log t3 Lo Word	R		I	For cal use
260	DeltaF Log t4 Hi Word	R		I	For cal use
261	DeltaF Log t4 Lo Word	R		I	For cal use
262	DeltaF Log t5 Hi Word	R		I	For cal use
263	DeltaF Log t5 Lo Word	R		I	For cal use
264	DeltaF Log t6 Hi Word	R		I	For cal use
265	DeltaF Log t6 Lo Word	R		I	For cal use
266	DeltaF Log t7 Hi Word	R		I	For cal use
267	DeltaF Log t7 Lo Word	R		I	For cal use
268	DeltaF Log t8 Hi Word	R		I	For cal use
269	DeltaF Log t8 Lo Word	R		I	For cal use
270	DeltaF Log t9 Hi Word	R		I	For cal use
271	DeltaF Log t9 Lo Word	R		I	For cal use
272	Ppmv Log t0 Hi Word	R		I	For cal use
273	Ppmv Log t0 Lo Word	R		I	For cal use
274	Ppmv Log t1 Hi Word	R		I	For cal use
275	Ppmv Log t1 Lo Word	R		I	For cal use
276	Ppmv Log t2 Hi Word	R		I	For cal use
277	Ppmv Log t2 Lo Word	R		I	For cal use
278	Ppmv Log t3 Hi Word	R		I	For cal use
279	Ppmv Log t3 Lo Word	R		I	For cal use
280	Ppmv Log t4 Hi Word	R		I	For cal use
281	Ppmv Log t4 Lo Word	R		I	For cal use
282	Ppmv Log t5 Hi Word	R		I	For cal use
283	Ppmv Log t5 Lo Word	R		I	For cal use
284	Ppmv Log t6 Hi Word	R		I	For cal use
285	Ppmv Log t6 Lo Word	R		I	For cal use
286	Ppmv Log t7 Hi Word	R		I	For cal use
287	Ppmv Log t7 Lo Word	R		I	For cal use
288	Ppmv Log t8 Hi Word	R		I	For cal use
289	Ppmv Log t8 Lo Word	R		I	For cal use
290	Ppmv Log t9 Hi Word	R		I	For cal use
291	Ppmv Log t9 Lo Word	R		I	For cal use
292-293	** INTERNAL USE ONLY **	X	X	X	DO NOT WRITE TO
294	Log Buffer Latest Log Pointer	R		A1	Points to start of latest log
295	Log Buffer Main Val Min – Hi_Word	R		I	
296	Log Buffer Main Val Min – Lo_Word	R		I	

297	Log Buffer Main Val Max – Hi_Word	R		I	
298	Log Buffer Main Val Max – Lo_Word	R		I	
299	Log1 - Hours/Minutes	R		H	
300	Log1 - Day/Month/Seconds	R		J	
301	Log1 - Main Value - Hi_ Word	R		I	
302	Log1 - Main Value - Lo_ Word	R		I	
303	Log1 - System Status Register	R		L	
304	Log1 - Warning Flags Register	R		M	
305	Log2 - Hours/Minutes	R		H	
306	Log2 - Day/Month/Seconds	R		J	
307	Log2 - Main Value - Hi_ Word	R		I	
308	Log2 - Main Value - Lo_ Word	R		I	
309	Log2 - System Status Register	R		L	
310	Log2 - Warning Flags Register	R		M	
>>>	>>> To log288	R		As above	

Table 11 Modbus Register Map

Register Configuration A

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

A1 — Unsigned Short. Range = 0 to 65535
A2 — Unsigned Short/10. Range = 0 to 6553.5
A3 — Unsigned Short/100. Range = 0 to 655.35
A4 — Unsigned Short/1000. Range = 0 to 65.535
A5 — Unsigned Short/1000. Range = 0 to 65.535

Conversion: Float*x = unsigned integer
Unsigned integer/x = float

Or cast:
Float value to read = ((float)(value))/x;
Unsigned short value to write = (unsigned short)(value*x)

Register Configuration B

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

B1 — Signed Short. Range -32768 to +32767
B2 — Signed Short/10. Range -3276.8 to +3276.7
B3 — Signed Short/100. Range -327.68 to +327.67
B4 — Signed Short/1000. Range -32.768 to +32.767
B5 — Signed Short/10000. Range -3.2768 to +3.2767

Most languages will cast from one type to another

Values to write into register manually:

If value is a negative number: (value*x)+65536
If value is 0 or a positive number: value*x

E.g. for type B3:
(-5.39*100)+65536 = 64997
(2.01*100) = 201

Or cast:

(Unsigned short)(value*x)

Reading Values from register manually:

If value in register is greater than 32767: (value-65536)/x
If vaue in register is less than or equal to 32767: value/x

E.g. for type B3:
(64997-65536)/100 = -5.39
201/100 = 2.01

Or cast:

((float)((signed short)value))/x;

Register Configuration C — Modbus Configuration

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
						PT	PT	IA	IA	IA	IA	IA	IA	IA	IA

Instrument Address (IA)	Protocol Type (PT)
1 to 31 (1=def)	00=RS485 (def) 01=USB VCP 10= Ethernet

Register Configuration D — System Configuration

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DC	DC	DF	BF	BP	SS	PS	PS	PU	PU	PU	TU	TU	LG	LG	LG

Temperature / Dew Point Units (TU)	Pressure for Dew-Point Calculations (PS)
00 = C (def) 01 = F	00= Atmospheric (def) 01 = Fixed pressure (User input value) 10 = External Line pressure (Ext sensor)

Pressure Units (PU)	DeltaF Mean Filter (DF)
000 = Bar.G (def) 001 = Bar.A 010 = Psi.G 011 = Psi.A 100 = Mpa 101 = mmHg	0 = Off 1= On (smooth's)
	BeatF Median Filter (BF)
	0=Off 1=On (reduces spikes)
Dew-Point Calculation Method to Use (DC)	**LG, SS, BP are for future use**
00=IGT 01=ISO 10=Ideal Gas (def)	LG = Language SS = Sensor Saver BP = Bypass Solenoid

Note: when a pressure unit or temperature unit is changed then the user must manually change the values for the following to the value in the new selected unit (if relevant).

- Fixed pressure for dew-point calculation
- External line pressure sensor min and max
- Alarm set-points
- Analog output ranges (low and high)

Register Configuration E — Alarm Configuration

Note: Alarm 4 is a system fault/warning alarm and is configured in Reg 9

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
L4	L3	L2	L1	A3	A3	A3	A3	A2	A2	A2	A2	A1	A1	A1	A1

Alarm1 Parameter (A1)	Alarm2 Parameter (A2)
0000 = Moisture – PPMv (def) 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA (wvp) 0100 = Moisture - LBMMSCF 0101 = Dew point 0110 = Oven temperature 0111 = Flow rate 1000 = Cell Pressure 1001 = Ext Line Pressure	0000 = Moisture – PPMv 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA (wvp) 0100 = Moisture - LBMMSCF 0101 = Dew point 0110 = Oven temperature (def) 0111 = Flow rate 1000 = Cell Pressure 1001 = Ext Line Pressure
Alarm3 Parameter (A3)	**Alarm Latch Control (L1 to L4)**
0000 = Moisture – PPMv 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA (wvp) 0100 = Moisture - LBMMSCF 0101 = Dew point 0110 = Oven temperature 0111 = Flow rate (def) 1000 = Cell Pressure 1001 = Ext Line Pressure	L1 = 1 = Alarm1 latch L2 = 1 = Alarm2 latch L3 = 1 = Alarm3 latch L4 = 1 = Alarm4 latch L1 = 0 = Alarm1 don't latch L2 = 0 = Alarm2 don't latch L3 = 0 = Alarm3 don't latch L4 = 0 = Alarm4 don't latch

Register Configuration F — Analog Output Config

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
						T2	T1	O2	O2	O2	O2	O1	O1	O1	O1

Ouput1 Parameter (O1)	Output2 Parameter (O2)
0000 = Moisture – PPMv (def) 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA 0100 = Moisture - LBMMSCF 0101 = Dew point 0110 = Oven temperature 0111 = Flow rate 1000 = Cell Pressure 1001 = Ext Line Pressure	0000 = Moisture – PPMv 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA 0100 = Moisture - LBMMSCF 0101 = Dew point (def) 0110 = Oven temperature 0111 = Flow rate 1000 = Cell Pressure 1001 = Ext Line Pressure
Output Type – (T1 to T2)	
0 = 4–20 mA 1 = 1–5V *(Where T1 is CH1 and T2 is CH2)*	

Register Configuration H — Time (hours / minutes)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
HH	HH	HH	HH	HH	HH	HH	HH	MM	MM	MM	MM	MM	MM	MM	MM

Hours Number (HH)	Minutes Number (MM)
00 to 23	00 to 59

Register Configuration I — 32 bit Precision Floating Point Representation

IEEE-754 single precision floating point format. This format is 'Big Ended' which means that the high byte is at a lower address in memory than the Lo byte, and is represented as such in the register memory map. The IEEE-754 format is shown below.

Bit 31	Bits 30 to 23	Bits 22 to 0
Sign bit 0 = + 1 = -	Exponent Field Has a +127 bias value	mantissa Decimal representation of binary. Where 1.0 <= value < 2.0

Examples of floating point to HEX are shown below:

1. +10.3

sign bit = 0
Exponent = 3, therefore exponent field = 127 + 3 = 130 , and bits 30 to 23 = 10000010.
The mantissa = 1.2875 which in binary representation = 1 .01001001 1001 1001 1001 101.

Adjusting the mantissa for the exponent moves the decimal point to the right if positive and to the left if negative. As the exponent is = 3 then the mantissa becomes = 1010.0100 1100 1100 1100 1 101, therefore:

1010 = (1x23) + (0x22) + (1x21) + (0x20) = 10 and
0100 1100 1100 1100 1101 = (0x2-1) +(1x2-2) + -- + (1x2-20) = 0.3

Therefore the word value = 0100 0001 0010 0100 1100 1100 1100 1101
= 4124CCCD

Consequently hi word= 4124 and lo word = CCCD

2. - 0.0000045

sign bit = l
Exponent = -18, therefore exponent field = 127 + (-18) = 109 , and bits 30 to 23 = 01101101.
The mantissa = 1.179648 which in binary representation = 1 .00101101111111010110101.

i.e. (1x2-18) + (1x2-21) + (1x2-23) etc.. = 0.0000045

Therefore the word value = 1011 0110 1001 0110 1111 1110 1011 0101
= B696FEB5

Register Configuration J — Date

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DD	DD	DD	DD	DD	MM	MM	MM	MM	YY	YY	YY	YY	YY	YY	YY

Date Number (DD)	**Month Number (MM)**
01 to 31	01 to 12
Year Number (YY) or Seconds	
00-99 for year or 00-59 for seconds	

Register Configuration K — Historic Calibration Log — Details

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MA	IE			CF	CF	CF	CF	CF	CF	CF	CF	CF	CF	CF	CF

Correction Factor (CF)	**Manual or Auto (MA)**
1 to 4000 /1000.0 = 0.001 to 4.000	0=Manual 1=Automatic
Internal or External (IE)	
0=Internal 1=External	

Register Configuration L — System Status Register — 229

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A4	A4	A3	A3	A2	A2	A1	A1	SS				SM	SM	CP	CP

Cycle Phase (CP)	System Mode (SM)
00= Reference phase 01= Sample Phase 10 = Cal Phase (internal or external)	00= Standby 01= Measurement 10 = Calibration
Relay Alarm Status flags	**Setup Status (SS)**
Example: A1 = 00=OK (relay de-energised) A1 = 01=High (or Fault)(relay energised) A1 = 10=Low (relay energised) A1 = 11= Latched (relay latched but condition now ok)	0 = Setup mode is OFF 1 = Setup mode is ON

Register Configuration M — System Warning Flags (Register 230)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	HEX	Warning Condition
0	0001	Oven temperature has not been stable within ±0.05C of setpoint for continuous 10 minutes
1	0002	(Process Alarms de-energised, Fault Alarm Active, both Analog Outputs at 3.6mA or 0.9V)
2	0004	Enclosure (System) temperature too high (> Oven temperature setpoint -2°C)
3	0008	MFC Flow control error (by >5ml/m of flow target)
4	0010	Cell pressure sensor error (under 4 mA, over 20 mA or no signal)
5	0020	Ext Press sensor error (under 4 mA, over 20 mA or no signal)
6	0040	Internal moist generator drift, instrument excessive drift or desiccant dryer deterioration requiring very large corr. factor (<0.2500 or >4.000). In this case the correction factor would be set to 1.0
7	0080	BeatF Under/Over acceptable range (<1500 Hz, >20000 Hz)
8	0100	ppm_V Over instrument range (>2000ppm_V)
9	0200	Oven temperature sensor fault (Process Alarms de-energised, Fault Alarm Active, both Analog outputs at 3.6 mA or 0.9 V) (ADC <10, >4000 counts)
10	0400	mA output 1 error (o/c or high resistance at output)
11	0800	mA output 2 error (o/c or high resistance at output)
12	1000	Oscillator board comms. error or board not present (checked on startup)
13	2000	Ethernet Board comms. error or board not fitted (checked on startup)
14	4000	Desiccant Dryer due for service or replacement (>5000000ppm_V)
15	8000	Internal Moisture Generator due for service or replacement (>1030days)

Fault selection mask (in Register 9) allows user to set which condition(s) trigger the fault relay alarm.

Register Configuration P1 — Next Calibration Configuration

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MA	IE	DH	MG					AC	AC	AC	AC	AC	AC	AC	AC

Manual or Auto (MA)	**Internal or External (IE)**
0 = Manual 1 = Auto	0 = Internal 1 = External
Data Hold (DH)	**Data Hold Additional Cycles (AC)**
0 = off 1 = on	0 to 240 cycles

Register Configuration P2 — Next Calibration Configuration — Intervals between cal

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	IH	IH	IH	IH	IH	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID

Hour of Day (IH)	**Interval Days (ID)**
0 to 23	1 day to 365 days

Register Configuration Q — Various Parameters, High Byte and Low Byte

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	GN	GN	GN	GN	GN

MFC Span in ml/m (MS)	**Gas Number (GN)**
0 to 2000 ml/m	0 to 23 Gases (see Appendix B2 for details).

Register Configuration T — Instrument Setup and Command Register (Regsiter 198)

Writing relevant number to this register initiates associated setting, calibration or test function

* Means only for Michel Factory use

** Put is setup mode first and then after test put back into measurement mode

2 = Set Cell Pressure 4 mA ADC Value*

3 = Set Cell Pressure 20 mA ADC Value*

4 = Set Ext Pressure 4 mA ADC Value*

5 = Set Ext Pressure 20 mA ADC Value*

6 = Send Test String to Sensor Comms Channel*

7 = Send Test String to Display Comms Channel*

10 = Force Analog Output 1 to 4 mA**

11 = Force Analog Output 1 to 20 mA**

12 = Force Analog Output 2 to 4 mA**

13 = Force Analog Output 2 to 20 mA**

14 = Force Analog Output 1 to 12 mA**

15 = Force Analog Output 2 to 12 mA**

20 = Set Alarm Relay1**

21 = Set Alarm Relay2**

22 = Set Alarm Relay3**

23 = Set Alarm Relay4**

25 = Set REF Solenoid* (uses 100% power to solenoid)**

26 = Set SAMPLE Solenoid* (uses 100% power to solenoid)**

27 = Set CAL Solenoid* (uses 100% power to solenoid)**

28 = All Solenoids Off* (uses 100% power to solenoid)**

30 = Set RTC Calibration ppm error value*

35 = Set Defaults Osc Board*

36 = Set Defaults Main Board* (Does not default the main board calibration values).

50 = Set System Mode to Standby (all solenoids off and no phase countdown)*

51 = Set System Mode to Measurement if in Cal mode (i.e. Abort Cal) OR Set to Manual Cal if in Auto cal countdown mode

52 = Set System Mode to Calibration if manual cal option set OR Start Auto Cal countdown mode if Auto Cal option set. (Only if oven temperature has become stable).

60 = Start on board SD Logging (Open log file)*

61 = Stop on board SD logging (Close log file)*

65 = Enter Board Setup Mode* (Normal measurement cycle and output/alarm updates are stopped)

66 = Exit Board Setup Mode*(Normal measurement cycle and output/alarm updates are re-started)

67 = Reset Ram Log Buffer and Stats to zeros

68 = Set Ethernet Settings (to values in Registers 245 to 250) – (Command not allowed via modbus)

70 = Reset Dryer Service flag and ppm sum register to 0.0ppm

71 = Reset Moist Generator Service flag and hours used counter to 0hr

74 = Clear Alarm1 Latch

75 = Clear Alarm2 Latch

76 = Clear Alarm3 Latch

77 = Clear Alarm4 (Fault) Latch

Register Configuration U — Internal Logging Configuration/Service Interval Days

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								RL	RL	RL	RL	DP	DP	DP	DP

DeltaF and ppm_v Log Interval in cycles (DP)	**Ram Buffer Log parameter (RL)**
Range is 1 to 15 cycles. (for CAL use, def = 1)	0000 = Moisture – PPMv (def) 0001= Moisture - PPMw 0010 = Moisture – MGM3 0011 = Moisture – PA (wvp) 0100 = Moisture - LBMMSCF 0101 = Dew point 1111 = No logging

Register Configuration U — Internal Logging Configuration/Service Interval Days

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DC	DC	DC	DC	DC	DC	DC	DC	ML	ML	ML	ML	ML	ML	ML	ML

Dryer Capacity or Used (DC) – in ppm	**Moisture Gen Capacity or Used (ML) – in Days**
0 to 255 x 100,000 represents 0 to 25,500,000 in 100,000 steps.	0 to 255 x 10 Represents 0 to 2,550 days (61200 hours) in 10 day steps

Register Configuration W — Signal Filter Settings

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
									BF	BF	DF	DF	DF	DF	DF

BeatF Median Filter (BF) Setting	**DeltaF Median Filter (DF) Sample size**
5 sample Median filter to remove spikes 1=Median of 1 (middle value) 3=Median of 3, averaged (default) Any other value = OFF	4-24 = Sample size of filter to smooth signal (default=12) < 4 or >24 = OFF

B.1 Set points and ranges

Set points and ranges for Analog Outputs, Alarms, Fixed User Pressure, Cell Pressure and External (line) Pressure sensor.

Unit	Adjustment Range/Res.	Default Values	Register Range	Register Type
ppm_V	0.0 to 3000.0	0.0 to 2000.0	0-30000	A2 (unsigned short/10)
ppm_W	0 to 40000	0 to 40000	0 to 40000	A1 (unsigned short)
mgm^3	0 to 20000	0 to 20000	0 to 20000	A1 (unsigned short)
Pa	0.0 to 3000.0	0.0 to 3000.0	0 to 30000	A2 (unsigned short/10)
dew point degC	-120.0 to +20.0	-100.0 to 0.0	-1200 to 200	B2 (signed short/10)
dew point degF	-184.0 to +68	-148.0 to 32.0	-1840 to 680	B2 (signed short/10)
lbmmscf	0 to 60000	0 to 60000	0 to 60000	A1 (unsigned short)
Oven T degC	-50.0 to +100.0	59.9 to 60.1	-500 to 1000	B2 (signed short/10)
Oven T degF	-58.0 to +212.0	139.8 to 140.2	-580 to +2120	B2(signed short/10)
Flow, ml/m	0.0 to 300.0	90.0 to 110.0	0 to 3000	A2(unsigned short/10)
Pressure, Psi.G	0.0 to 3000.0	0.0 to 3000.0	0 to 30000	A2 (unsigned short/10)
Pressure, Psi.A	14.7-3014.7	15.0-3015.0	147 to 30147	A2 (unsigned short/10)
Pressure, Bar.G	0.00 to 204.08	0.00 to 204.00	0 to 20408	A3 (unsigned short/100)
Pressure, Bar.A	1.00 to 205.08	1.00 to 205.00	1 to 20508	A3 (unsigned short/100)
Pressure, Mpa	0.01 to 20.78	0.01 to 21.00	1 to 2078	A3 (unsigned short/100)
Pressure, mmHg	750 to 65535 (limited)	750 to 65000	0 to 65535 (limited)	A1 (unsigned short)

Notes:

ppm_W

Based on 0-2000 ppm and mol weight of gas variation of 1 to 200, and mol weight of water of 18.

At 0 ppmv = 0*(18/200) = 0ppm_W
At 2000 ppmv = 2000*(18/200 = 180ppm_W
At 0 ppmv = 0*(18/1) = 1ppm_W
At 2000 ppmv = 2000*(18/1) = 36000ppm_W

Dew Point
This is based on data available in ISO or IGT table which ranges between -88 to +20.

Water Vapor Pressure (Pa)
Using HumiCal, at -100°Cdp Wvp is 0.001pa and at +20 wvp is 2332.636pa.

Lbmmscf
This is ppmv *21.4 = so 2000*21.4 = 42800.

mgm^3
Using calc at *http://www.skcinc.com/converter/converter.asp.*
1ppm with mol weight of 1 = 0.05mgm^3
1ppm with mol weight of 200 = 8.2mgm^3
2000ppm with mole weight of 1 = 81.8 mgm^3
2000ppm with mol weight of 200 = 16359.9mgm^3

Pressure
All pressure values based on 0-3000psig except mmHg which is limited by 16bit register size.
http://www.engineeringtoolbox.com/pressure-units-converter-d_569.html

B.2 Gases for Gas Correction Values

Gases for gas correction values, indexed 0 to 23. If a USER gas is selected then the instrument will use the gas correction values that are set in the respective registers 38, 39 and 40 for the Flow correction and at registers 41, 42 and 43 for the molecular weights.

0 = Air - Mixture
1 = Ar - Argon
2 = CH4 - Methane
3 = C2H2 - Ethyne
4 = C2H4 - Ethelyne
5 = C2H6 - Ethane
6 = C3H6 - Propylene
7 = C3H8 - Propane
8 = C4H10 - Butane
9 = CO - Carbon Monoxide
10 = CO2 - Carbon Dioxide
11= H2 - Hydrogen
12 = He - Helium
13 = Kr - Krypton
14 = N2 - Nitrogen
15 = Ne - Neon
16 = NH3 - Ammonia
17 = NO - Nitrogen Oxide
18 = N2O - Nitrous Oxide
19 = O2 - Oxygen
20 = XE - Xenon
21 = UserGas1
22 = UserGas2
23 = UserGas3

Appendix C

EU Declaration of Conformity

Appendix C EU Declaration of Conformity

EU Declaration of Conformity

MICHELL Instruments

Manufacturer: **Michell Instruments Limited**
48 Lancaster Way Business Park
Ely, Cambridgeshire
CB6 3NW. UK.

CE

We declare under our sole responsibility that the product:

QMA401 Moisture Analyser

complies with all the essential requirements of the EU directives listed below.

2014/30/EU	**EMC Directive**
2014/35/EU	**Low Voltage Directive (LVD)**
2011/65/EU	**Restriction of Hazardous Substances Directive (RoHS2)**

and has been designed to be in conformance with the relevant sections of the following standards or other normative documents.

EN61326-1:2006	Electrical equipment for measurement, control and laboratory use – EMC requirements –Class A (emissions) and Industrial Locations (immunity).
EN61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

Andrew M.V. Stokes, Technical Director

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EUD QMA401 Issue 01

Appendix D

Quality, Recycling & Warranty Information

Appendix D Quality, Recycling & Warranty Information

D.1 Pressure Equipment Directive (PED) 97/23/EC

The above Directive has been implemented in United Kingdom Law by the Pressure Equipment Regulations 1999.

The Regulations require that all pressure equipment and assemblies within the scope of the Pressure Equipment Directive must be safe when placed on the market or put into service.

Michell Instruments' products have been assessed and, as referenced against the Classification Charts detailed in Annex II of the Directive, do not fall in to the requirements for CE Marking compliance with the Pressure Equipment Directive.

Article 3, paragraph 3 states that any product containing a pressurised fluid that does not qualify for compliance should, nevertheless, be constructed with Sound Engineering Practice (SEP).

Michell Instruments attests here that its products have been designed, manufactured & tested to assure safe operation, and in accordance with Sound Engineering Practices.

D.2 Recycling Policy

Michell Instruments is concerned with the protection of the environment. It is our commitment to reduce and eliminate from our operations, wherever possible, the use of substances which may be harmful to the environment. Similarly, we are increasingly using recyclable and/or recycled material in our business and products wherever it is practical to do so.

To protect natural resources and to promote material reuse, please separate batteries from other types of waste and recycle responsibly. If batteries are not properly disposed of, these substances can cause harm to human health and the environment.

The product that you have purchased may contain recyclable and/or recycled parts and we will be happy to provide you with information on these components if required. For further information please see the following sections.

D.3 WEEE Compliance

Directive 2012/19/EU 4 July 2012 on Waste Electronic and Electrical Equipment (WEEE)

The Waste Electronic and Electrical Equipment (WEEE) Directive places rules upon European manufacturers of electrical and electronic equipment. The directives' aim is to reduce the impact that electronic devices have on the environment.

Michell Instruments is in full compliance with the WEEE Directive and is registered with an approved recycler (Registration No. WEE/JB0235YW) and treats the requirement of the directive and the protection of the environment with the utmost importance. All Michell Instruments' products are appropriately marked indicating their requirement for recycling.

It may be required to return certain instruments for treatment at the end of their working life.

Feb 2013

D.4 RoHS2 Compliance

Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011

The Restriction of Hazardous Substances (RoHS) Directive places rules upon European manufacturers of electrical and electronic equipment. The directives' aim is to reduce the impact that electronic devices have on the environment.

According to the EC Directive 2002/95/EC Michell Instruments' products qualify as Category 9, Control and Monitoring Equipment. Under the 2002/95/EC Directive, Category 9 products are exempt from compliance with the Directive.

However, the careful design of all Michell Instruments' products takes into consideration the requirements of the Directive and, wherever possible, compliance is achieved. All future products will be developed entirely using compliant materials. Furthermore, Michell Instruments is taking active steps to remove non-compliant materials and components from existing products wherever these may occur. Presently, none of the non-compliant materials are known to occur in Michell Instruments' products.

The new Directive 2011/65/EU (RoHS2) entered into force on 21 July 2011 and required all Member States to transpose the provisions into their respective national laws by 2 January 2013.

Under the provisions of the RoHS2 EU Directive 2011/65/EU (Article 3, [24]) defines "Control and Monitoring Equipment" specifically as "monitoring and control instruments designed exclusively for industrial or professional use".

RoHS2 EU Directive 2011/65/EU states the closing date for compliance of any Control and Monitoring Equipment product sold into the EU market place as 22nd July 2017.

However, the careful design policy of all Michell Instruments' products continues to attain compliance in the shortest practical timescales and strives to ensure that less than 0.1% of total mass per product, of all non-compliant materials, appear within them. Michell Instruments continues to monitor suppliers and material sources to ensure that compliance of goods provided is maintained.

January 2013

D.5 Warranty

Unless otherwise agreed, the Supplier warrants that, as from the date of delivery for a period of 12 months, the goods and all their component parts, where applicable, are free from any defects in design, workmanship, construction or materials.

The Supplier warrants that the services undertaken shall be performed using reasonable skill and care, and be of a quality conforming to generally accepted industry standards and practices.

Except as expressly stated, all warranties whether express or implied, by operation of law or otherwise, are hereby excluded in relation to the goods and services to be provided by the Supplier.

All warranty services are provided on a return to base basis. Any transportation costs for the return of a warranty claim shall reside with the Customer.

D.6 REACH Compliance

Regulation (EC) No. 1907/2006
Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

Michell Instruments is a manufacturer of moisture measurement and gas analysis instrumentation and is a 'downstream' user of chemicals, as described by the EU Council Directive 76/769/EEC. The products we supply are not raw chemical products (goods).

Under normal and reasonably foreseeable circumstances of application, the goods supplied to you shall not contain or release any prohibited chemicals. No listed SVHC (Substances of Very High Concern) appear within products manufactured by Michell Instruments. Therefore the 0.1% mass per product, or total usage of 1 tonne/year, will never be exceeded. For these reasons we are neither required by obligation for registration nor for the creation of material safety data sheets (MSDS) for our products.

Our continued review of the SVHC Candidate List and latest additions is to ensure we remain compliant.

Michell Instruments maintains a hazardous material register in which MSDS data sheets are collated, and we will check that our suppliers will comply to REACH requirements for all materials and substances we use in the processes of our manufacturing.

In the unlikely event that any chemicals of concern appear in our products in quantities greater than 0.1% of total mass per product we will immediately inform you by correspondence according to the REACH Article 33 requirements. Our current appraisal is, however, that we do not expect or foresee such an incidence.

January 2013

D.7 Return Policy

If a Michell Instruments' product malfunctions within the warranty period, the following procedure must be completed:

1. Notify a Michell Instruments' distributor, giving full details of the problem, the model variant and the serial number of the product.
2. If the nature of the problem indicates the need for factory service then the instrument should be returned to Michell Instruments, carriage prepaid, preferably in the original packaging, with a full description of the fault and the customer contact information.
3. Upon receipt, Michell Instruments will evaluate the product to determine the cause of the malfunction. Then, one of the following courses of action will be taken:
    - If the fault is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
    - If Michell Instruments determines that the fault is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs, at standard rates, will be provided. Upon receipt of the owner's approval to proceed, the product will be repaired and returned.

D.8 Calibration Facilities

Michell Instruments' calibration facilities are among the most sophisticated in the world and have been recognized for their excellence.

Traceability to the National Physical Laboratory (NPL) UK is achieved through our UKAS Accreditation (Number 0179). This covers dew point over the range -90 to +90°C (-130 to +194°F) and also Relative Humidity.

Dew-point calibrations are also traceable to the National Institute for Standards & Technology (NIST) USA over the range -75 to +20°C (-103 to +68°F).

NOTE: Standard traceable calibration certificates for instruments and sensors are not issued under our UKAS accreditation.

D.9 Manufacturing Quality

Michell Instruments is registered with the British Standards Institute for Quality Assurance to:

BS EN ISO 9001: 2008

Rigorous procedures are performed at every stage of production to ensure that the materials of construction, manufacturing, calibration and final test procedures meet the requirements laid down by our BSI approved Quality System.

Please contact Michell Instruments (www.michell.com) if the product does not arrive in perfect working order.

D.10 FCC (EMC Requirements for North America)

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the user manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. This product must be operated as per the operating instructions provided. Do not make any alterations or modifications to the product. Any unauthorized alterations or modifications made to this product may require you to stop operating the product.

Canadian Radio Interference Regulations.

This Class A digital product complies with Canadian ICES-001. Règlement canadien sur les interférences radio. Ce produit numérique de classe A est conforme à la norme NMB-001.

Appendix E

Return Document & Decontamination Declaration

Appendix E Return Document & Decontamination Declaration

Decontamination Certificate

IMPORTANT NOTE: Please complete this form prior to this instrument, or any components, leaving your site and being returned to us, or, where applicable, prior to any work being carried out by a Michell engineer at your site.

Instrument			Serial Number	
Warranty Repair?	YES	NO	Original PO #	
Company Name			Contact Name	
Address				
Telephone #			E-mail address	
Reason for Return /Description of Fault:				

Has this equipment been exposed (internally or externally) to any of the following? Please circle (YES/NO) as applicable and provide details below		
Biohazards	YES	NO
Biological agents	YES	NO
Hazardous chemicals	YES	NO
Radioactive substances	YES	NO
Other hazards	YES	NO
Please provide details of any hazardous materials used with this equipment as indicated above (use continuation sheet if necessary)		
Your method of cleaning/decontamination		
Has the equipment been cleaned and decontaminated?	YES	NOT NECESSARY

Michell Instruments will not accept instruments that have been exposed to toxins, radio-activity or bio-hazardous materials. For most applications involving solvents, acidic, basic, flammable or toxic gases a simple purge with dry gas (dew point <-30°C) over 24 hours should be sufficient to decontaminate the unit prior to return.
Work will not be carried out on any unit that does not have a completed decontamination declaration.

Decontamination Declaration

I declare that the information above is true and complete to the best of my knowledge, and it is safe for Michell personnel to service or repair the returned instrument.

Name (Print)		Position	
Signature		Date	

MICHELL Instruments

F0121, Issue 2, December 2011

http://www.michell.com